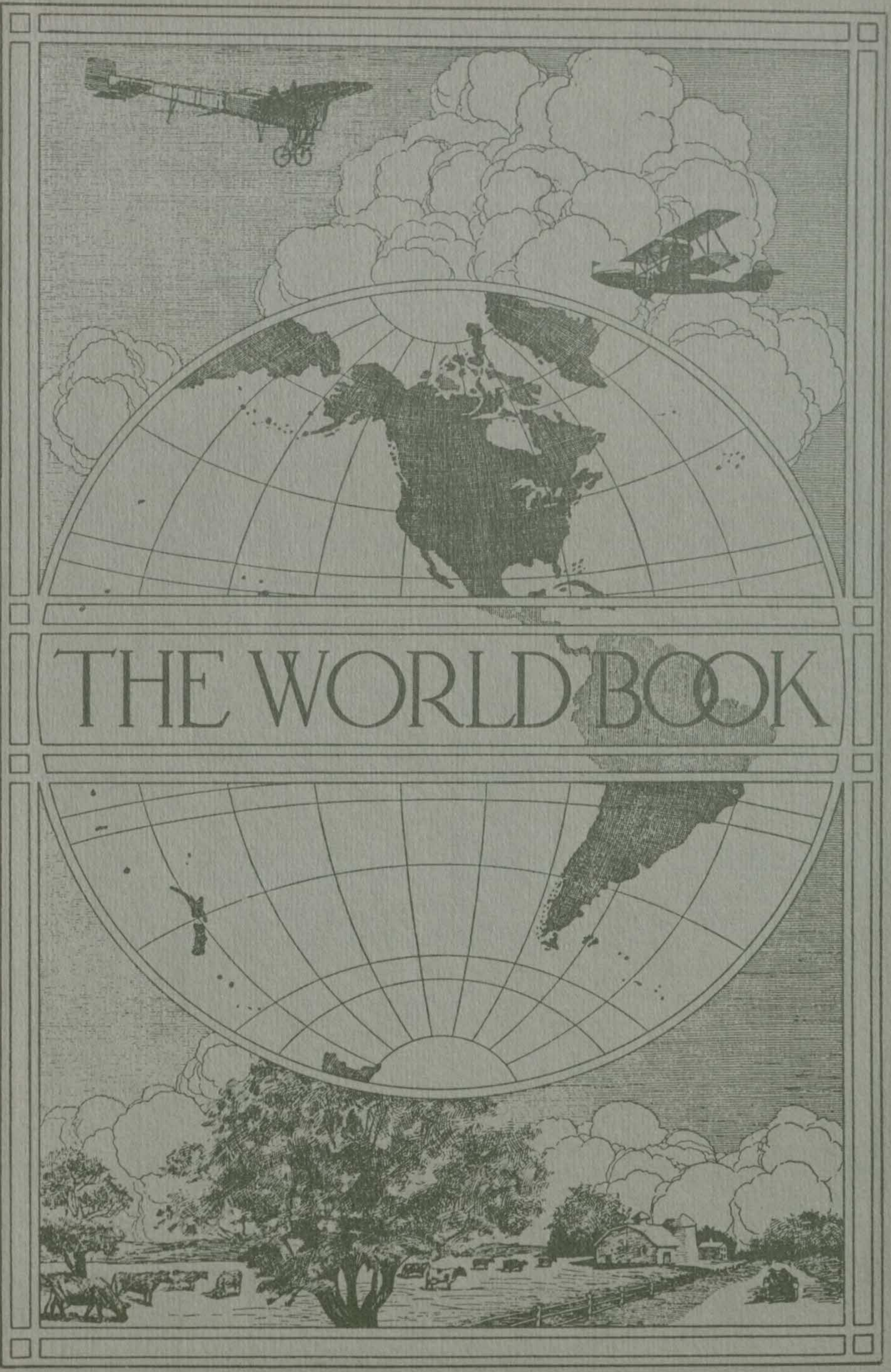
THE WORLD BOOK



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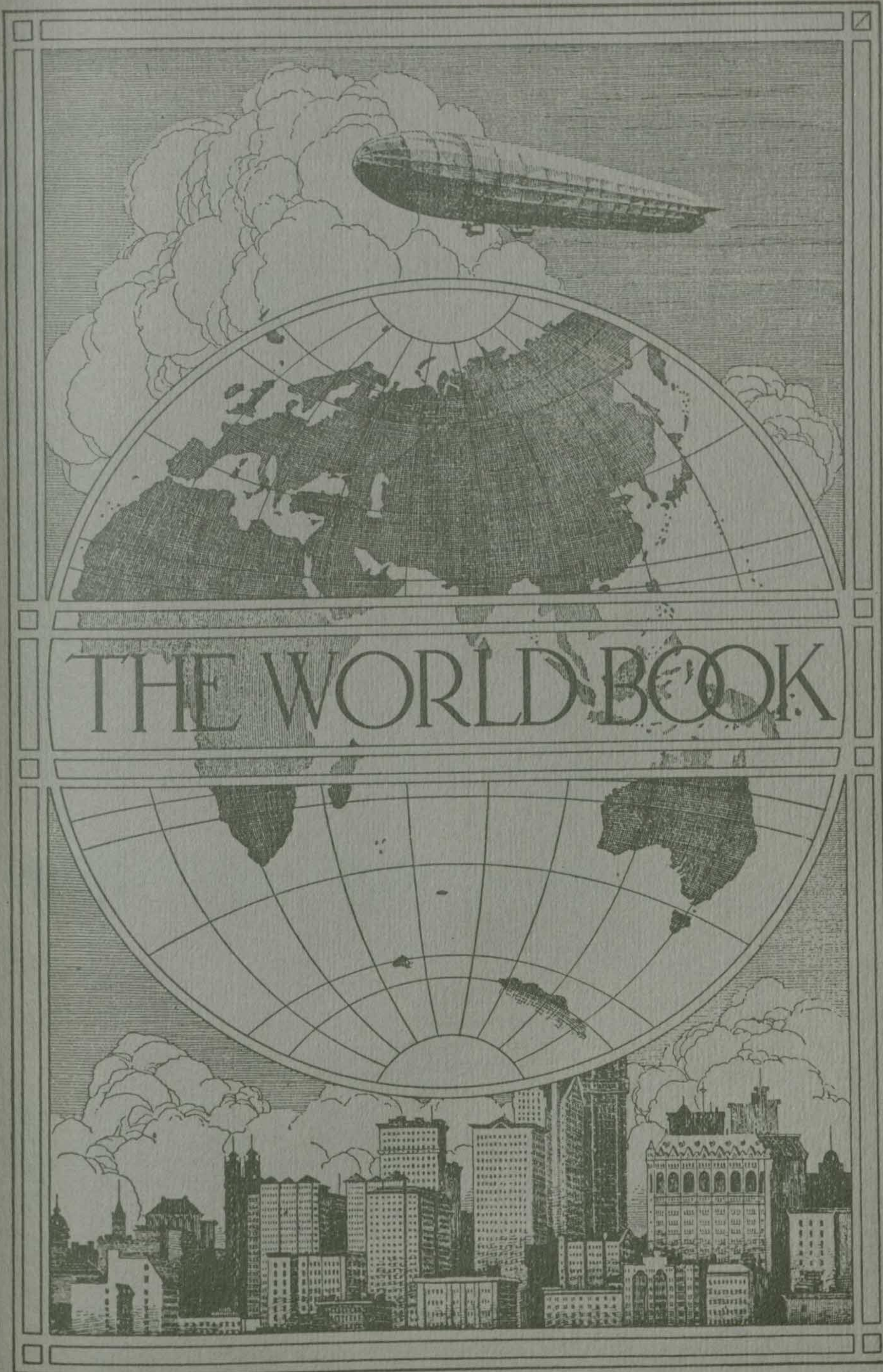
THE WORLD BOOK

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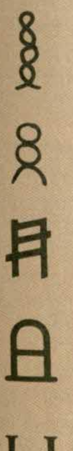
Hh

H is the eighth letter of the English alphabet. It was also a letter in the alphabet used by the Semites, who once lived in Syria and Palestine. The Semites named the letter *cheth,* and adapted an Egyptian *hieroglyphic,* or picture symbol, for a twisted hank of rope to represent the letter. The ancient Greeks later took the letter into their alphabet and named it *eta.* They gave it the sound of long *e.* The Romans borrowed the letter from the Greeks, and gave it its final capital form. They also gave it its present sound of *h.* See **Alphabet.**

Uses. *H* or *h* ranks as about the ninth most frequently used letter in books, newspapers, and other printed material in English. When used in abbreviations, *h* may stand for *hardness. H* represents *His* or *Her* in the abbreviation *H. M., His* or *Her Majesty.* In chemistry, *H* stands for the element *hydrogen,* and in physics it represents the intensity of a magnetic field. *H* means *henry,* the unit of inductance, in electricity. The abbreviation for *harbour* is *h; h.c.p.* means *handicap;* and *h.p.* means *horsepower.*

Pronunciation. In English, people pronounce *h* by shaping their lips for the sound of the vowel that follows it. Their vocal cords are apart. In words such as *hail, hat,* and *haste,* a slight impulse of breath normally crosses the vocal cords. But when the *h* sound occurs between two vowels, as in the words *behind* or *ahead,* the *h* sound may be voiced. *H* is silent in words such as *hour* and *honest.* See **Pronunciation.**

Development of the letter H



The ancient Egyptians, about 3000 B.C., wrote a symbol that represented a twisted length of rope.

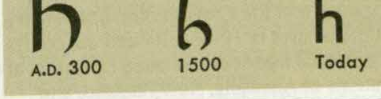
The Semites modified the Egyptian symbol about 1500 B.C. They called it *cheth.*

The Phoenicians, about 1000 B.C., made the letter with three crossbars.

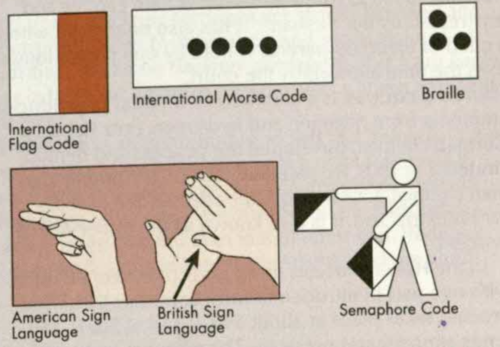
The Greeks added the letter to their alphabet about 600 B.C. They named the letter *eta.*

The Romans borrowed the letter from the Greeks about A.D. 114. They gave the H the shape and sound we use today.

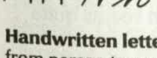
The small letter h first appeared during the A.D. 300's as a rounded letter. By about 1500, the letter had developed its present shape.



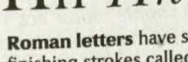
Special ways of expressing the letter H



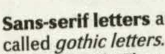
Common forms of the letter H



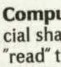
Handwritten letters vary from person to person. *Manuscript* (printed) letters, *left,* have simple curves and straight lines. Cursive letters, *right,* have flowing lines.



Roman letters have small finishing strokes called *serifs* that extend from the main strokes. The type face shown above is Baskerville. The italic form appears on the right.



Sans-serif letters are also called *gothic letters.* They have no serifs. The type face shown above is called Futura. The italic form of Futura appears on the right.



Computer letters have special shapes. Computers can "read" these letters either optically or by means of the magnetic ink with which the letters may be printed.

H-bomb. See Nuclear weapon.

Habakkuk, Book of, is a book of the Old Testament, or Hebrew Bible. The book is named after Habakkuk, an Israelite prophet. A reference to the Chaldeans in the book indicates that Habakkuk lived about 600 B.C.

The Book of Habakkuk is only 56 verses long. It consists of two parts. The prophecies appear in the form of laments and responses in Chapters 1 and 2. Chapter 3 is a hymn. In one of his prophecies, Habakkuk asks why the innocent and good should suffer with the wicked. God answers, "The just shall live by his faith" (Hab. 2:4). Habakkuk closes with a hymn celebrating God's victory over His enemies. Some scholars think the last chapter was composed for use in temple worship. The book formed the basis of an important ancient Biblical commentary found in the Dead Sea Scrolls (see **Dead Sea Scrolls**).

Habana, La. See Havana.

Habeas corpus is a legal term which, in its original Latin, means *you are ordered to have the body.* If a person has been arrested or is held by the police, a lawyer or friend can obtain a *writ of habeas corpus.* This writ orders the police to produce the arrested person in court. The court then decides if the police have sufficient reason to hold the prisoner.

The writ is one of the basic guarantees of personal freedom in England and systems based on English law. It prevents unjust or wrongful imprisonment or detention by legal authorities. No person can be denied the writ except in times of public danger or under martial law.

In 1679, the Habeas Corpus Amendment Act was passed in England. The act strengthened the use of habeas corpus by stating that the Crown could not detain a prisoner against the wishes of Parliament and the courts. This concept of personal freedom has been carried over into the legal systems of Australia, New Zealand, and many other countries.

Besides its common use, the writ of habeas corpus has been used to free a wife who is held captive and mistreated by her husband. It has also been used when a child of divorced parents is held by one parent longer than the time allowed by the court.

Haber process is a commercial method of producing ammonia from nitrogen and hydrogen. Fritz Haber, a German chemist, developed the process and demonstrated it in 1909. He patented it in 1910. Another German chemist, Carl Bosch, later adapted the process for industrial use. It is also known as the *Haber-Bosch process.*

In the Haber process, three parts of hydrogen unite with one part of nitrogen to form ammonia (NH_3). The process takes place at about 550° C and at 200 to 250 times atmospheric pressure. The nitrogen and hydrogen combine at the surface of a solid *catalyst,* a substance that speeds up the reaction. It consists mainly of iron, with small amounts of alumina and potassium oxide. All the hydrogen and nitrogen do not combine. The uncombined gases are recirculated through the process.

Almost all modern ammonia plants use the Haber process or variations of it. Most early ammonia plants that used the Haber method obtained hydrogen from *water gas* and nitrogen from *producer gas.* Water gas and producer gas are made from hot coke (see **Gas** [How gas is manufactured]). Today, many ammonia plants obtain hydrogen and nitrogen from other sources. Hydrogen may be obtained from natural gas, and nitrogen may come from the distillation of liquid air (see **Liquid air**). Other modifications of the process include changes in the composition of the catalyst and in the temperature and pressure used.

Habgood, John Stapylton (1927-   ), became archbishop of York, in England, in July 1983. Noted for his High Church, moderately liberal views, he had served as bishop of Durham since 1973. Habgood attended Eton College and took science degrees at Cambridge University. He then studied theology at Oxford University. After two years as a curate in London, he served as principal of theological colleges in Cambridge and Birmingham and was rector of St. John's Church, Jedburgh, in Borders Region, Scotland, from 1962 to 1967.

Habit is something a person learns to do over and over again without thinking about how to do it. Many everyday actions are habits. Imagine how difficult it would be to tie your shoelaces if you had to think of every action needed to complete the bow. A habit is different from an *instinct.* An instinct is behaviour that is inborn, instead of learned (see **Instinct**).

How we learn habits. Most habits begin as actions that a person is aware of. The more the person performs an action, the easier it becomes. Strong habits become automatic, and require little or no thought.

Psychologists generally agree that a *stimulus* (something that starts an action) must be present each time the habit is carried out. For example, a red traffic light is a stimulus to an experienced driver. It triggers the response of pressing the brake pedal. To learn this habit, each new driver must practise under actual traffic conditions, learning to press the brake pedal when the light is red.

Many psychologists believe that people will learn a habit only if it benefits them. Psychologists call this satisfaction a *reward* or a *reinforcement.* If the habit satisfies people, they tend to keep it. When a habit offers no reward or becomes unpleasant, they may *break* (discard) it. For example, some people get pleasure from smoking. Because of the pleasure (reward), smoking becomes a habit. If the habit becomes unpleasant (no longer brings a reward), a person may stop smoking.

Psychologists who support the reward idea of habit formation disagree with an older idea. The older idea said that "paths" were made in the nervous system when an act was repeated. However, psychologists have taught rats habits and then cut their nervous systems at many points. Despite the cuts, the rats continued to perform the habits. This result suggests that the learning of habits does not depend on specific nerve connections and does not occur only in particular parts of the brain.

Kinds of habits. Some habits are simple and require only movements of the muscles. When approaching a door, a person grasps the doorknob. This action is called a *simple motor act.* The movement seems quite natural, but the person once had to learn this habit. A doorknob is a strange thing to a child when first encountered. The child may play with the doorknob many times before learning to open the door by turning the knob.

Some habits are more than simple motor acts. They are thoughts and attitudes we have about things and people. Psychologists call them *habits of adjustment.* Some of these habits are "good" and others are "bad," depending on how they affect other people. We learn "good" habits to act as others expect us to act. Neat appearance and pleasant manners are considered good habits. A person may learn "bad" habits, thinking something can be gained from them. But such habits may be annoying to others.

See also **Learning; Behaviour.**

Habitat is the kind of place in which a plant or an animal usually lives in nature. Water lilies and cactus plants have different habitats. The habitat of deep-sea fishes is quite different from that of goats. Various animals and plants can be kept alive outside their natural habitats if given special care in aquariums, zoos, or botanical gardens.

Plants and animals live where they can satisfy their needs. Every habitat limits the kinds of things that live there, and their numbers. Goldfish and pond plants require fresh water. On the other hand, the barnacles that cling to a ship must live in salt water. In some cases, creatures can adapt themselves to a changing habitat.

A single area may satisfy the needs of many kinds of plants and animals. These organisms that associate together in a common habitat form communities. Communities exist in various places, including (1) on the seashore, (2) in deserts, (3) in freshwater lakes, and (4) in tropical forests.

See also **Animal** (Where animals live); **Plant** (Where plants live); **Ecology.**

Habsburg, House of, was a famous European royal family. The Habsburgs (also spelled *Hapsburg*) ruled the Holy Roman Empire for nearly 400 years. Members of the family occupied thrones in Europe from the 1200's to the early 1900's, except for a few years.

The name *Habsburg* comes from one of the family's first castles, the *Habichtsburg (Hawk's Castle),* built about 1020 in Switzerland. In 1273, Rudolf became the first member of the Habsburg family to be elected Holy Roman emperor. Three years later, he conquered Austria, which became the Habsburgs' new home. Beginning in 1438, family members were elected Holy Roman emperor almost without interruption until 1806.

In the late 1400's, Maximilian I greatly increased the family's power by arranging a number of marriages between Habsburgs and members of other royal houses. By 1519, his grandson Charles V had inherited many kingdoms, including Spain and the Spanish empire in America. In 1522, Charles gave Austria to his younger brother Ferdinand. Through marriage, Ferdinand acquired Hungary and Bohemia four years later. Thus, after 1526, the Habsburgs consisted of two branches—a Spanish line headed by Charles's descendants, and an Austrian line descended from Ferdinand.

The Spanish branch lasted until 1700. Charles VI, the last male heir of the Austrian Habsburgs, died in 1740. In 1736, Charles's daughter Maria Theresa married Francis Stephen, Duke of Lorraine. As Francis I, he regained the throne of the Holy Roman Empire for the family in 1745. The descendants of Francis and Maria Theresa were Holy Roman emperors until 1806 and emperors of Austria from 1804 to 1918.

Related articles in ***World Book.*** For information on Habsburg rule, see the *History* section in the articles **Austria; Belgium; Czechoslovakia; Germany; Hungary; Prague; Switzerland;** and **Vienna.** See also:

Charles (Holy Roman emperors)
Ferdinand II
Ferdinand III
Francis II (Holy Roman emperor)
Francis Joseph
Holy Roman Empire
Maria Theresa
Maximilian I

Hacienda is a large farm or country estate in Spanish America. In such countries as Mexico, most farms are called haciendas. The word *hacienda* may also refer to the main building on the estate. Many haciendas have adobe walls (see **Adobe**). Large wooden beams fastened with rawhide strips support a low, sloping tile roof. Haciendas are built for inside coolness and outdoor living. Shady verandas may surround three sides of a *patio* (open court). See also **Mexico** (Agriculture).

Hackberry is the name of several species of trees of the elm family that are valued for their wood, have edible fruits and are planted as ornamental trees. They grow mainly in tropical areas, though a few species are temperate. The European hackberry is commonly planted as a street tree in the Mediterranean region. It has grey-green, lance-shaped leaves. The wood is yellow-brown and is used to make woodwind musical instruments, and household utensils.

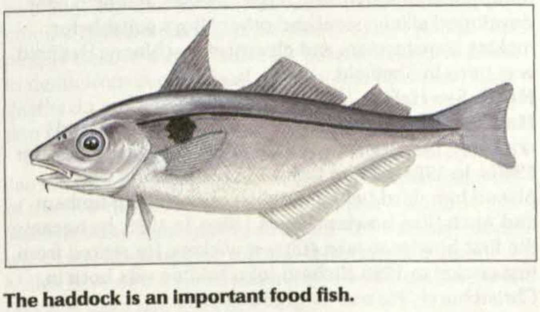
Scientific classification. Hackberries belong to the elm family Ulmaceae, genus *Celtis.* The European hackberry is *C australis.*

Hackney (pop. 164,200) is a borough in Greater London. It is situated in east London and includes the former boroughs of Hackney, Shoreditch, and Stoke Newington. Hackney is a residential district, but it has many industries that manufacture such goods as ballet shoes, saddles, stained-glass windows, and toys. Marie Lloyd, the music-hall artist, was born in Hackney. Shoreditch Church, whose bells feature in the rhyme "Oranges and Lemons," is also in Hackney.

Hackney. See **Horse** (table: Some types and breeds).

Hackney carriage is a vehicle that stands or plies for hire. The term generally covers taxis, hire cars, buses, and trams. Hackney carriages are strictly licensed and controlled, some by the police, and some by local authorities. The name *hackney carriage* comes from *hackney* (a breed of horse). A hackney was a horse available for hire.

Haddock is an important food fish that belongs to the cod family. A black line along each of its sides and a black spot just behind its head distinguishes the haddock from other cod. The front fin on the haddock's back is more pointed than that of other cod. Haddock live on both sides of the North Atlantic and are abun-



The haddock is an important food fish.

dant in the North Sea. Young haddock live in surface waters. They often live among the tentacles of large jellyfish. Adult haddock live near the seabed. Haddock weigh about 1.5 kilograms and are about 60 centimetres long. Haddock travel in schools. They feed on crabs, shrimp, worms, and small fish.

The worldwide commercial catch of haddock is approximately 435,000 metric tons each year. Most of the catch is taken with large, funnel-shaped nets called *otter trawls.* Haddock are sold fresh and frozen and are made into fillets, fish fingers, and smoked fish products.

Scientific classification. Haddock belong to the cod family, Gadidae. The common haddock is *Melanogrammus aeglefinus.*

Hades was the god of the dead in Greek mythology. He ruled the kingdom of the dead, which had the same name. The ancient Romans preserved without change almost all the myths about Hades and his kingdom, but they called the god Pluto.

Hades was the son of Cronus and Rhea, and the older brother of Zeus, the king of the gods. In spite of Hades' importance to the Greeks, they did not devote any rituals to him. Few myths involve Hades directly.

The kingdom of Hades was a neutral region reserved for the souls of people who deserved neither punishment nor reward upon death. The Greeks believed that Hades was drab and dull, but not necessarily painful. The souls of those who had led virtuous lives dwelled happily in Elysium. The souls of those who had sinned greatly went to Tartarus, a land far below the earth. There, they suffered eternal torment.

The Greeks believed Hades was beneath the earth. It had five rivers—the Acheron, the Kokytos, the Lethe, the Phlegethon, and the Styx. Each served as a boundary between the land of the living and the land of the dead.

The Styx was the best-known river in Hades. To cross it, a soul had to be ferried by Charon, a boatman. He demanded payment, so the Greeks placed coins in the mouths of their dead before burying them. Hades' house stood on the shore of the Styx. Cerberus, a monstrous three-headed dog, guarded the house. After crossing the river, each soul was assigned to its proper eternal home by one of three judges—Aeacus, Minos, or Rhadamanthys. Those guilty of serious offences were tormented by three goddesses called *Furies* or *Erinyes.*

Related articles in ***World Book*** include:

Cerberus
Charon
Elysium
Furies
Hell
Lethe
Persephone
Pluto (god)
Sisyphus
Tartarus

Hadfield, Sir Robert Abbott (1859-1940), an English metallurgist, discovered a nonmagnetic manganese steel. This steel is extremely hard wearing and is ideal for applications involving large stresses. Hadfield later developed silicon steel and other alloys suitable for making transformers and electrical machinery. Hadfield was born in Sheffield.

Hadj. See Hajj.

Hadlee, Sir Richard (1951-), a New Zealand cricketer, became one of the world's top bowlers in the 1980's. In 1988, he had taken 373 test wickets. This placed him third behind English cricketer Ian Botham and Australian bowler Dennis Lillee. In 1990, he became the first bowler to take 400 test wickets. He retired from test cricket in 1990. Richard John Hadlee was born in Christchurch. He was knighted in 1990.

Hadow, Sir William Henry (1859-1937), an English educationist, helped originate the Eleven-Plus examination (see **Eleven-Plus**). He was chairman of a committee that produced in 1926 a report called *The Education of the Adolescent.* It recommended that the type of school a child should attend on leaving primary school should depend on the results of an examination taken at the age of "eleven plus." Hadow was born at Ebrington, in Gloucestershire.

Hadrian (A.D. 76-138), a Roman emperor, stabilized Roman law into a single, uniform code, and made government more efficient. The law code served as a basis for the Justinian Code, established in the 500's by the Byzantine emperor Justinian I (see **Justinian Code**). Hadrian started an empire-wide communications system similar to the American pony express. He fortified parts of the frontier, and built a stone wall in northern Britain (see **Roman walls**). He founded two new cities—Antinoopolis in Egypt and Hadrianople in Thrace (now Edirne, Turkey). Hadrian also completed the huge temple of Zeus in Athens, which had been begun in the 500's B.C.

Hadrian's official name was Publius Aelius Hadrian. He was born in Spain. His father died during Hadrian's youth, and Trajan, Hadrian's cousin, became his guardian. Trajan became emperor in 98. Hadrian held military and civilian government posts and travelled to the northern and eastern frontiers of the empire. He became emperor after Trajan's death in 117.

Hadrian was a poet, an amateur architect, and a student of Greek culture. His reign was generally peaceful. He rejected Trajan's aggressive policies, ending a war with Parthia, a land beyond Rome's eastern frontiers. To avoid further wars, he returned Parthian territory that Rome had won. The only major conflict occurred in 132, when Jews in Palestine revolted. Hadrian crushed the revolt in 135. He made Jerusalem a Roman city and forbade Jews to worship there. In 138, Hadrian picked Titus Aurelius Antoninus (Antoninus Pius) to succeed him.

Hadrian IV, pope. See **Adrian IV.**

Hadrian's Wall was built by the Roman Emperor Hadrian in the A.D. 120's across northern Britain between Solway Firth and the mouth of the River Tyne. It was built to mark the northern boundary of Roman Britain and to prevent attacks and smuggling by the Picts and Scots.

The wall was built partly of stone and partly as a rampart of turf. There was a small fort, called a *milecastle,* every mile (about 1.6 kilometres), and there were 23 large forts. The *Vallum* is a ditch running parallel to the wall. Long stretches of the wall remain.

See also **Roman walls.**

Hadron is a major group of subatomic particles. Hadrons include protons and neutrons, which are found in an atom's nucleus. Hadrons are readily affected by the *strong interaction,* a force that holds the nucleus together.

Hadrons consist of smaller particles called *quarks* and *antiquarks.* These smaller particles occur in two combinations, which form the chief types of hadrons—*mesons* and *baryons.* A quark linked to an antiquark makes up a meson. Three quarks combined comprise a baryon. The baryon has an antimatter counterpart called an *antibaryon,* which consists of three antiquarks. See **Antimatter.**

All hadrons except protons and neutrons are extremely unstable. They disintegrate spontaneously in a few hundred millionths of a second or less. For this reason, only protons and neutrons are found in ordinary matter. However, physicists can readily produce unstable hadrons by causing a beam of high-energy particles to collide with matter. They have discovered nearly 300 kinds of hadrons by this means.

All hadrons are nearly the same size, ranging from about 0.7 to 1.7 *femtometres* (quadrillionths of a metre) in diameter. But hadrons vary widely in mass. The lightest, the *pions,* have only about $\frac{1}{7}$ of an *atomic mass unit* (see **Atom** [Atomic weight]). The heaviest, the *upsilons,* carry more than 10 atomic mass units.

See also **Baryon; Gluon; Meson; Quark; Upsilon particle.**

Haeckel, Ernst Heinrich (1834-1919), a German zoologist, became known for his theory of *recapitulation.* This theory states that each animal during its growth as an embryo repeats the changes its ancestors underwent (see **Embryo**). For example, if a land animal had ancestors which lived in water and used gills, then each embryo of that animal continues to develop gills as did its ancestors, even though the gills may be lost during later embryonic development. Haeckel studied embryos of many animals and made drawings, which are still seen in biology books. He also used his findings to support Charles Darwin's theory of evolution (see **Darwin, Charles R.**). Haeckel's widely read book, *The Riddle of the Universe* (1899), explained many of his theories. He was the first to draw a "family tree" of animal life, showing the supposed relationships of the various animal groups. His early work included a study of one-celled sea animals.

Haeckel was born in Potsdam. He liked botany, but studied medicine at his father's insistence. He was educated at Würzburg and Berlin universities. He served as a professor of zoology at the University of Jena from 1862 to 1909.

Haemangioma. See **Birthmark.**

Haemapheresis. See **Blood transfusion** (How blood is collected and stored).

Haematite is an ore that supplies most of the world's iron. It is a *ferric oxide* (a compound of iron and oxygen) and has the chemical formula Fe_2O_3. In its purest form, haematite consists of about 70 per cent iron. The ore occurs in a variety of forms, including shiny crystals; grainy rock; and loose, earthy material. Haematite is black, brownish-red, or dark red, but a fresh scratch on haematite rock is blood-red. The word *haematite* means *bloodlike. Red ochre,* an earthy form of haematite, is used to colour paint.

Deposits of haematite are found in most countries in the world. Important deposits of the ore occur in Australia, Brazil, Canada, China, India, Russia, South Africa, and Ukraine. Sources include Australia, Brazil, Russia, South Africa, and Ukraine.

See also **Taconite.**

Haemoglobin is the pigment that transports oxygen in the blood. It is in the red blood cells and gives blood its red colour. When the red cells file through the *alveoli,* or air sacs, of the lungs, they take up oxygen. The haemoglobin combines with the oxygen to form a compound called *oxyhaemoglobin.* When the red cells travel through the rest of the body, they give up the oxygen to the tissues. In the tissues, the haemoglobin takes up carbon dioxide, and releases it in the alveoli of the lungs. The carbon dioxide is then exhaled.

Haemoglobin is a complex molecule that includes iron and a protein called *globin.* Anaemia may result from a lack of haemoglobin or from hereditary abnormalities in the haemoglobin (see **Anaemia**). Some poisons combine with haemoglobin in such a way that it can no longer combine with oxygen. Thus, aniline dyes and other chemicals cause the formation of *methaemoglobin,* which cannot take up oxygen. The blood then turns bluish-brown. Carbon monoxide, a poisonous gas, mixes readily with haemoglobin, making the blood bright red. But the gas keeps blood from taking up oxygen.

Scientists have identified many different kinds of haemoglobin. A person's haemoglobin type is inherited. *Haemoglobin A* ranks as the most common type. One abnormal type, called *haemoglobin S* or *sickle haemoglobin,* causes the disease sickle cell anaemia. Red blood cells that contain mostly haemoglobin S may become stiff and misshapen. These cells may then plug blood vessels. See **Sickle cell disease.**

See also **Blood; Haemolysis; Iron; Perutz, Max F.**

Haemolysis is the breakdown of red blood cells. In the final stages of breakdown, *haemoglobin* (red pigment) is released from the red cells. Haemolysis in small amounts is a normal body process. About 0.8 of 1 per cent of all red cells in the body are *haemolysed* (broken down) each day.

Haemolysis is usually balanced by red cell production in the *marrow* (centre part) of the bones. But, sometimes so many cells break down that marrow production is insufficient, and anaemia may result. Chemical poisons may cause excessive haemolysis. Or haemolysis may occur when the body produces *autoantibodies* which cause red cells to break down.

Haemophilia is a hereditary disease in which the blood does not clot normally. People with haemophilia, called *haemophiliacs,* bleed excessively because their blood clots extremely slowly. Almost all haemophiliacs are males.

Blood normally contains a number of substances called *clotting factors* which enable clotting to take place. A haemophiliac's blood lacks the active form of one of these factors. Haemophiliacs suffer most when small internal blood vessels rupture and are not sealed off by the clotting mechanism. Leaking blood then accumulates in such areas as the head or joints. This puts pressure on the surrounding tissues and causes pain, swelling, and loss of function. Many haemophiliacs become crippled from repeated bleeding into joints. Some people believe it is possible for haemophiliacs to bleed to death from even a small external cut. However, such deaths do not occur because blood contains other clotting factors that halt bleeding from the skin.

How haemophilia is inherited. Haemophilia is caused by a defective gene on the *X chromosome,* one of the two chromosomes that determine a person's sex (see **Heredity** [Patterns of heredity]). The *Y chromosome,* which has no genes for clotting factors, is the other. Males have one X chromosome and one Y chromosome. Females have two X chromosomes.

A boy who inherits the haemophilia defect on his X chromosome will be a haemophiliac. A girl who inherits the defective gene on one of her X chromosomes will be a *carrier.* She may transmit the defective gene to her children. But she will not be a haemophiliac because the normal gene on her other X chromosome provides enough of the essential clotting factor. In extremely rare cases, a girl inherits the defective gene on both X chromosomes and will be a haemophiliac.

Major types of haemophilia include classical haemophilia and Christmas disease. The name of Christmas disease comes from the last name of one of the first patients to be treated for it. About 85 per cent of all haemophiliacs have classical haemophilia. Their blood lacks a protein called *clotting factor number VIII.* Nearly all others have Christmas disease, which involves the lack of *clotting factor number IX.* An extremely small number of haemophiliacs lack another kind of clotting factor.

A blood disorder called *von Willebrand's disease* is sometimes confused with haemophilia. Unlike haemophilia, von Willebrand's disease causes prolonged external bleeding and affects both sexes. However, few people with this blood disorder suffer bleeding into the joints.

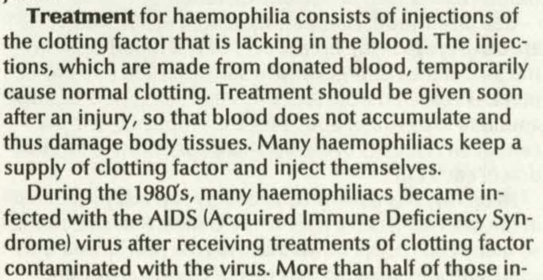
Treatment for haemophilia consists of injections of the clotting factor that is lacking in the blood. The injections, which are made from donated blood, temporarily cause normal clotting. Treatment should be given soon after an injury, so that blood does not accumulate and thus damage body tissues. Many haemophiliacs keep a supply of clotting factor and inject themselves.

During the 1980's, many haemophiliacs became infected with the AIDS (Acquired Immune Deficiency Syndrome) virus after receiving treatments of clotting factor contaminated with the virus. More than half of those infected have died from AIDS. Since 1985, use of a screening test to detect the AIDS virus in donated blood has greatly increased the safety of treatments with clotting factor in many countries.

See also **AIDS; Bleeding; Blood** (Blood clotting).

Haemophilia

Haemophilia is a hereditary disease in which the blood does not clot normally. It results from a defective gene on the X chromosome, one of two sex chromosomes. Males have one X and one Y chromosome. Females have two X chromosomes.



In the chart above, the small red x indicates the chromosome with the defect. A male who inherits the defective gene has haemophilia. A female who inherits it on only one X chromosome is a *carrier.* She does not have the disease, but she can pass the defective gene on to her children. Each son of a normal father and a carrier mother has one chance in two of being a haemophiliac. Each daughter has one chance in two of being a carrier.

Haemorrhage is bleeding, either within the body (internal) or through a break in the skin (external). Severe haemorrhage may bring on dizziness or a sick feeling. Patients become pale, and their pulse and breathing are weak and rapid. They may go into a condition known as *shock.* Loss of too much blood will result in death. See also **Bleeding; Cerebral haemorrhage; First aid; Tourniquet.**

Haemorrhoids are enlargements of the veins of the rectum. This condition is often called *piles.* There are two sets of veins in the rectum. The *internal* veins line the lower rectum and extend upwards. The *external* veins lie beneath the skin at the *anus* (rectal opening). When any of these veins *dilate* (enlarge), they become haemorrhoids.

Many people seem to inherit a tendency to develop haemorrhoids. However, any condition that causes prolonged or repeated increase in the blood pressure in the rectal veins may contribute to the development of haemorrhoids. Such conditions include constipation, pregnancy, and long periods of standing.

Haemorrhoids of the external veins usually cause little discomfort unless a blood clot forms in the affected vein and causes inflammation. Haemorrhoids of the internal veins may bleed or descend through the anus as a result of bowel movements. Such haemorrhoids may cause pain or itching.

Mild cases can be treated with medicated ointments or *suppositories* (inserted capsules), or by soaking in warm water. In cases where the victim repeatedly suffers painful attacks or bleeding, a doctor may remove the haemorrhoids surgically.

Hafiz (?-1389?), also spelled Hafez, is the poetic name of the Persian poet *Mohammed Shams ud-Din* Hafez. His chief work was a *divan,* a collection of about 700 poems. He wrote odes and *quatrains* (four-line rhymes). The people of Persia (now Iran) called Hafiz "the Tongue of the Hidden" because of the sweetness and beauty of his lyrics. They looked on his poems as love songs. His name in Arabic means "one who knows the Quran by heart." He was born in Shiraz.

Hafnium, a chemical element, is a silver-coloured metal. It absorbs neutrons better than most metals and is resistant to corrosion. For these reasons, rods made of hafnium are used to control the rate of reactions in nuclear reactors of nuclear submarines. When the reaction rate is too high, the rods are pushed into the reactor to absorb some of the neutrons. When the rate is low, the rods are withdrawn. Hafnium is also used in some gas-filled and incandescent lamps.

The highest concentrations of hafnium occur in the minerals zircon and baddeleyite. Hafnium is always found in combination with the more common element zirconium, which it resembles in its chemical and physical properties. Hafnium is a common by-product of the production of this element.

Hafnium has the chemical symbol Hf. Its atomic number is 72 and its atomic weight is 178.49. It melts at about 2227° C and boils at 4602° C. Its specific gravity is 13.31 grams per cubic centimetre. Dirk Coster, a Dutch physicist, and Georg von Hevesy, a Hungarian chemist, discovered hafnium in 1923 in Copenhagen, Denmark. The word *hafnium* comes from *Hafnia,* the Latin name for Copenhagen.

See also **Zirconium.**

Hagar. See **Ishmael.**

Hagen, Walter (1892-1969), was a great American golfer and the player most responsible for elevating professional golf into a major sport. Hagen's insistence on first-class treatment at tournaments raised the stature of professional golfers during a time when amateur players dominated the game. His popularity greatly contributed to making golf a spectator sport.

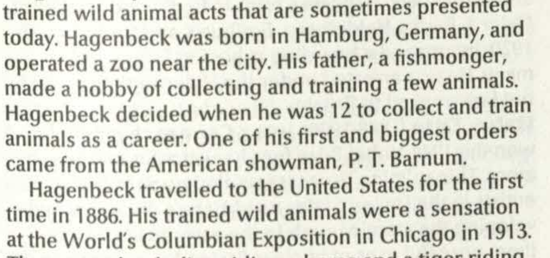
Hagen's skill as a player combined with his showmanship and colourful lifestyle to make him golfs first celebrity in America. Hagen sometimes arrived for a match in a chauffeur-driven limousine and wearing a dinner jacket. He was the first U.S. golfer to earn more than a million U.S. dollars in tournaments and exhibitions and the first U.S. player to market golf equipment bearing his name.

Walter Charles Hagen was born in Rochester, New York, U.S.A. Between 1914 and 1929, he won 11 major tournaments. He won the United States Open in 1914 and 1919; the British Open in 1922, 1924, 1928, and 1929; and the Professional Golfers' Association (PGA) tournament in 1921, 1924, 1925, 1926, and 1927.

Hagenbeck, Carl (1844-1913), organized the type of trained wild animal acts that are sometimes presented today. Hagenbeck was born in Hamburg, Germany, and operated a zoo near the city. His father, a fishmonger, made a hobby of collecting and training a few animals. Hagenbeck decided when he was 12 to collect and train animals as a career. One of his first and biggest orders came from the American showman, P. T. Barnum.

Hagenbeck travelled to the United States for the first time in 1886. His trained wild animals were a sensation at the World's Columbian Exposition in Chicago in 1913. The spectacle of a lion riding a horse and a tiger riding an elephant appealed to the public and forward-looking circus people. A group of American showmen operated the Carl Hagenbeck Circus in 1905 and 1906. It became the famous Hagenbeck-Wallace Circus, which performed from 1907 to 1938. But Hagenbeck was never a proprietor of this circus.

Hagfish is an eellike fish related to the lampreys. Hagfishes live in the sea. Some live in deep water and others in muddy bays. A hagfish has a round mouth surrounded by six short *barbels* (tentacles). Its tongue has sharp, horny teeth. It uses them to bore into dead or dying fish and eat their flesh. Hagfishes produce large amounts of slime. When disturbed, the *Atlantic hagfish* produces enough slime to fill a bucket in about a minute.



A pair of hagfish produce eggs. Hagfish have sensitive barbels around their mouth, and poorly developed eyes.

Scientific classification. Hagfishes make up the hagfish family, Myxinidae. The Atlantic hagfish is *Myxine glutinosa.*

See also **Fish** (Lampreys and hagfish; picture: The chief kinds of fish); **Lamprey.**

Haggai, Book of, is a book of the Old Testament, or Hebrew Bible, named after an ancient Hebrew prophet. Haggai lived in Jerusalem about 520 B.C. The Jews had just returned from exile in Babylon, and Haggai convinced them to take up the task of rebuilding the holy Temple in Jerusalem. Haggai preached that the rebuilt Temple would signify the return of God's favour to the Jewish people and would bring them better times. He called upon the priests to purify certain religious activities. He addressed Zerubbabel, the Persian-appointed governor of Judah, about a glorious future age when God would destroy foreign kingdoms. Then a king, a descendant of the great King David, would reign.

Haggard, Sir Henry Rider (1856-1925), was one of the most successful English writers of popular fiction in the late 1800's. He wrote 58 volumes of fiction, and 7 volumes of economic, political, and social history. Haggard's best novels are based on his experiences in Africa.

King Solomon's Mines (1885) became a young people's classic. It is the story of a search for the legendary lost treasure of King Solomon. *She* (1887) is the story of Ayesha, a white goddess of Africa who is 2,000 years old but still appears young and beautiful.

Haggard was born in Norfolk, England. After studying law, he moved to South Africa in 1875 to serve as secretary to the governor of Natal, a South African province. Haggard was knighted in 1912.

Hagia Sophia is the finest and most famous example of Byzantine architecture in the world. It was built as a Christian cathedral by the emperor Justinian I between A.D. 532 and 537 in Constantinople (now Istanbul). After an earthquake damaged the original dome, a higher one was built between 558 and 563. The building was used as a *mosque* (Muslim temple) after 1453 when the Turks conquered the city. Since 1935, Hagia Sophia has served as a museum. Hagia Sophia is a Greek phrase that means Holy Wisdom. It is sometimes called Saint Sophia.

The inside appearance is one of great space, height, and richness. The rare and costly building materials were brought from many parts of the Roman Empire. The marble-lined walls have many colours and designs. Mosaics decorate some of the walls and vaults. These were covered over by the Turks. After the building became a museum, the mosaics were uncovered. Many beautiful pictures were found. Among these are figures of Christ and the Virgin Mary and portraits of various rulers.

The floor plan of Hagia Sophia is oblong. The building is 76 metres from east to west and 72 metres from north to south. Over the centre is the great dome, 56 metres above the floor and measuring 33 metres across.

See also **Architecture** (pictures).

The Peace Palace was built in The Hague in the early 1900's. It serves as headquarters for the Permanent Court of Arbitration and the International Court of Justice.

Hague, The (pop. 449,338; met. area pop. 677,962), is the seat of the Netherlands government and the official residence of the country's monarch. It is officially called 's Gravenhage, which means *the count's hedge.* Many important European treaties have been signed at The Hague. However, Amsterdam is the capital of the Netherlands.

In the early 1900's, the world's eyes hopefully turned toward The Hague. Peace-loving peoples dreamed that it might become the neutral capital of the world, where representatives of all nations could meet to settle quarrels and prevent war. A magnificent Peace Palace was built as a monument to that dream. Andrew Carnegie, an American industrialist, funded the Palace, which still serves as headquarters for the Permanent Court of Arbitration and the International Court of Justice.

The Hague lies on the southwest coast of the Netherlands, about 5 kilometres inland from the North Sea (see **Netherlands** [map]). Unlike most other Dutch cities, The Hague lies mostly above sea level. Adjacent to The Hague on the north is Scheveningen, a fishing town and the largest seaside resort in the Netherlands.

The Hague is a handsome city with many large parks and quiet, tree-lined streets. Its stately old buildings and elegant residences are reminders that the city was inhabited by aristocrats and government officials rather than by the merchants who dominated other Dutch cities. The Hague has three royal palaces, including *Huis ten Bosch* (House in the Woods), the residence of the country's monarch. At the heart of the old part of the city stand the parliament buildings, called the Binnenhof. The Mauritshuis, a famous art museum, is next to the Binnenhof. The Hague has several churches that date from the Middle Ages.

The economy of The Hague depends mainly on the government, which is the city's chief employer. The growth of government has required the construction of many new office buildings in The Hague. The city has little industry, but several large firms have offices or headquarters there.

History. The Hague was originally a hunting lodge belonging to the count of Holland. In 1250, it became the count's residence. When the Netherlands became independent in the 1500's, The Hague became the seat of the States-General, the parliament that governed all the provinces that were united in the new Dutch republic. The Triple Alliance of England, Sweden, and Holland was signed at The Hague in 1668, and the Triple Alliance of England, France, and Holland was signed there in 1717.

At the suggestion of the Russian czar, a peace conference took place in the city in 1899. By then The Hague had become a permanent site for international conferences. In 1907, representatives of European nations met in The Hague in an unsuccessful effort to solve the problems which later led to the outbreak of World War I (1914-1918).

The city was occupied by German forces in 1940, during World War II. War damage was extensive. The Germans set up a defence system at Scheveningen and launched V-2 rockets from The Hague. The Allies bombed The Hague 50 times before freeing it from the Germans in 1945.

Hahn, Kurt (1886-1974), an educationist, founded Gordonstoun School, in Grampian Region, Scotland, in 1934. For the next 20 years, he practised and developed his educational theories, which were based on fitness and selfrespect. Hahn was born in Berlin and studied at Oxford, Berlin, Heidelberg, Freiburg, and Göttingen. In 1920, he opened a boarding school at Salem, in Germany. He was arrested under the Hitler régime in 1933, but later moved to Britain.

Hahn, Otto (1879-1968), was a German chemist who won the 1944 Nobel Prize for chemistry for splitting the atom. This splitting process is called *nuclear fission.* Scientists in the United States used Hahn's discovery in developing the atomic bomb in the early 1940's. Since then, peaceful uses of nuclear fission have also been developed.

Hahn first split the uranium atom in 1938. He and his associate, Fritz Strassmann, were studying the effects of bombarding uranium with neutrons. They found that the bombardment changed some of the uranium to barium, an element with about half the atomic weight of uranium. In 1939, Austrian-born physicists Lise Meitner and Otto Frisch explained that barium resulted from a splitting of the uranium atom.

Hahn studied many radioactive substances, including actinium and thorium. In 1917, he and Meitner shared the credit for the discovery of a radioactive metal called *protactinium* (see **Protactinium**).

Hahn was born in Frankfurt am Main, Germany. He received a Ph.D. degree from the University of Marburg in 1901. In 1912, he joined the faculty of the Kaiser Wilhelm Institute for Chemistry (now the Max Planck Institute in Göttingen). Hahn became president of the institute in 1946.

See also **Nuclear energy** (Development).

Hahnemann, Samuel (1755-1843), a German doctor, founded the homeopathic method of treating disease. He believed that a drug which produces symptoms in a healthy person will cure those symptoms in a sick person (see **Homeopathy**). Hahnemann published his major work, the *Organon der rationellen Heilkunst (Principles* *of Rational Medicine),* in 1810. The book contains his chief ideas: to let like cure like, that medicines become more potent as they are diluted and shaken, and that only one remedy should be given at a time. Hahnemann was born in Meissen, Germany. His full name was Christian Friedrich Samuel Hahnemann. He practised in many towns in Germany—especially in Leipzig—and later in Paris.

Haifa (pop. 266,100; met. area pop. 374,950) is Israel's chief port and an important manufacturing and cultural centre. It lies on and around Mount Carmel in northern Israel. The city borders on the Bay of Haifa at the eastern end of the Mediterranean Sea. For location, see **Israel** (map). Haifa has three sections. The lower section, which spreads around the bottom of Mount Carmel, includes port facilities, warehouses, blocks of flats, and scattered slums. The main business district covers most of the mountain slopes. The upper part of Haifa consists mostly of large houses, blocks of flats, and gardens and parks on top of the mountain.

Many religious landmarks are in Haifa, including the Bahai Temple, the Monastery of Our Lady of Mount Carmel, and Elijah's Cave. The prophet Elijah hid in the cave to escape from his enemies.

The city's industries include oil refining and the manufacture of cement, chemicals, electronic equipment, glass, steel, and textiles. Haifa is also a shipping and railway centre. Haifa has two universities.

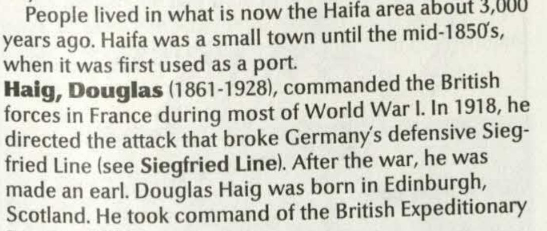
People lived in what is now the Haifa area about 3,000 years ago. Haifa was a small town until the mid-1850's, when it was first used as a port.

Haig, Douglas (1861-1928), commanded the British forces in France during most of World War I. In 1918, he directed the attack that broke Germany's defensive Siegfried Line (see **Siegfried Line**). After the war, he was made an earl. Douglas Haig was born in Edinburgh, Scotland. He took command of the British Expeditionary Force in 1915.

Haiku. See **Japanese literature.**

Hail is a precipitation in the form of round or irregularly shaped lumps of ice. These lumps of ice are called *hailstones.* Hailstones range from the size of peas to the size of oranges or larger. Most hailstones are smaller than 2.5 centimetres in diameter. Large hailstones can have bumps on their surfaces where they have grown more.

Hail can break windows, damage roofs, and dent cars and aeroplanes. It also causes a huge amount of damage to crops. Damage from hail is greater when the wind is strong. Occasionally, people caught in the open in severe hailstorms have been killed.



The largest hailstone on record, *above,* fell at Coffeyville, Kansas, on Sept. 3, 1970. It weighed 0.76 kilogram and measured 44.5 centimetres round.

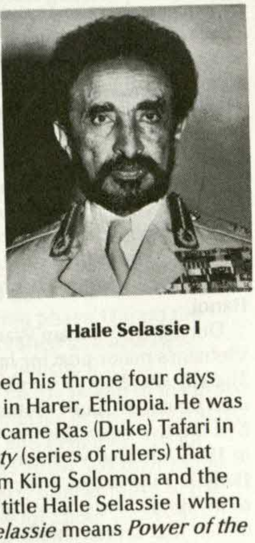
Hail occurs in temperate or subtropical climates where sharp changes of temperature happen. High plains and mountainous regions create the most favorable conditions for hail. For these reasons, hail often falls in Argentina, northern Italy, Kenya, South Africa, the Caucasus region between the Black and Caspian seas, and the central plains of the United States.

Hailstones form in thunder clouds and begin as frozen raindrops or snow pellets called *hail embryos.* Embryos originate in one part of the hailstorm and are then carried by air currents to the main region of hail growth. Hailstones develop as the embryos come into contact with *supercooled water droplets,* droplets that remain liquid at temperatures below freezing. As an embryo moves through the droplets, they strike its surface and freeze. An embryo grows into a hailstone as this freezing water accumulates on its surface.

Hailstones become large if they remain for a long time in parts of the hailstorm where there is a large amount of supercooled liquid water. Hailstones grow large if they are supported in the same cloud updraught for a long time. They also grow if they repeatedly fall out of an updraught but are then carried upward by other air currents. Hailstones fall to the ground when they leave the region of updraughts or become too heavy for the air currents to support them. They fall at a speed of about 35 kilometres per hour or more.

See also **Sleet; Storm.**

Haile Selassie I (1892-1975) became emperor of Ethiopia in 1930. His reign ended in 1974, when military leaders overthrew him and set up a provisional government.



Haile Selassie I

Haile Selassie worked for economic and social reforms, such as making slavery punishable by law. He gave Ethiopia its first written constitution in 1931. Ethiopia was attacked by Fascist Italy in 1935, and Haile Selassie lived in exile in England until 1941. British forces liberated Ethiopia during World War II and restored him to the throne. Rebels seized the government on Dec. 13, 1960, while he was in South America, but he regained his throne four days later. Haile Selassie was born in Harer, Ethiopia. He was born Tafari Makonnen. He became Ras (Duke) Tafari in 1916. He belonged to a *dynasty* (series of rulers) that claimed to be descended from King Solomon and the Queen of Sheba. He took the title Haile Selassie I when he became emperor. *Haile Selassie* means *Power of the Trinity.*

See also **Ethiopia** (History); **Jamaica** (People).

Hailsham, Lord (1907-), Quintin McGarel Hogg, served as lord chancellor in Great Britain from 1970 to 1974, and from 1979 to 1987. He held several ministerial posts in the Conservative governments of the late 1950's and early 1960's, particularly dealing with education and

Haiphong still has buildings that date from the time of French colonial rule (1883-1940), such as the Opera House, *above.*

science. Born in London and educated at Oxford, Hogg was MP for Oxford City from 1938 to 1950, when he succeeded his father as Viscount Hailsham. He became a queen's counsel in 1953. In 1963, he renounced his peerage and was elected MP for Marylebone. But as lord chancellor, he became a life peer.

Haines, Janine (1945-), was the first woman in Australian history to head a political party. She was leader of the Australian Democrats from 1986 to 1990. Haines was born in Tanunda, South Australia. She was educated at the University of Adelaide and became a teacher. She married and had two children. She first entered Parliament in 1977 to fill a Senate vacancy.

Haiphong (pop. 1,190,900) is a manufacturing centre and seaport in northern Vietnam. The city lies near the Gulf of Tonkin, about 90 kilometres east of Hanoi (see **Vietnam** [map]). Factories in Haiphong produce cement, china, glass, phosphates, and textiles. Other industries include electric power production, food processing, and shipbuilding. The city is a deepwater port for Hanoi. Products shipped to Haiphong are carried by rail to Hanoi.

During the Vietnam War, Haiphong became North Vietnam's major port for importing military supplies. The city was heavily bombed during the war. North Vietnam defeated South Vietnam in the war in 1975 and unified the two countries into the single nation of Vietnam in 1976. See also **Vietnam War.**

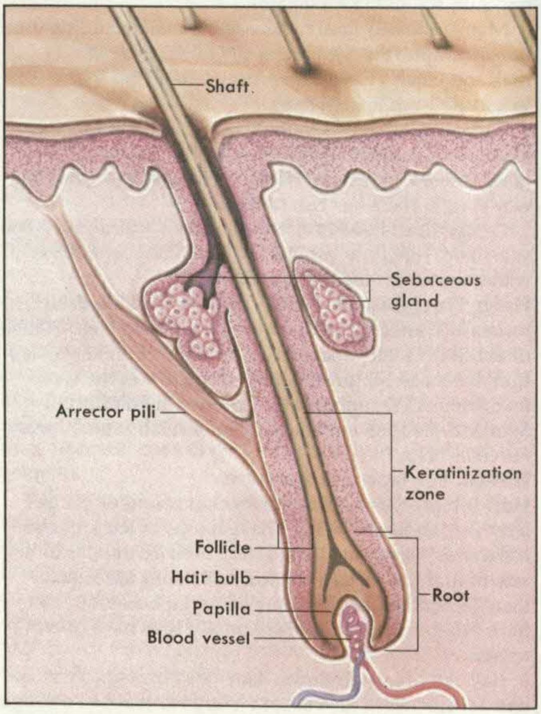
Hair is a threadlike structure that grows from the skin of mammals. Most kinds of mammals have a thick coat of hair that serves chiefly to provide warmth. Many species also have certain hairs for special uses, such as for protection or for sense functions. Among human beings, however, hair also has a cosmetic value.

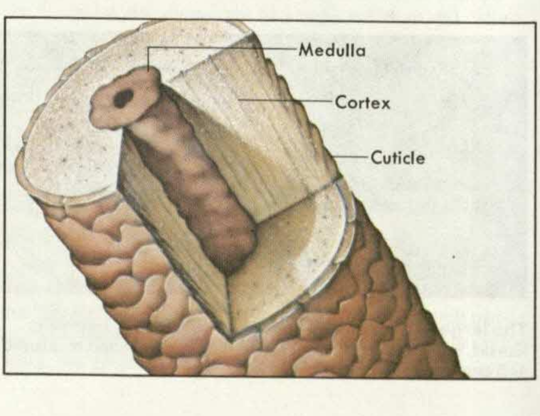
Most of the human body is covered by tiny, light-coloured hairs that are barely visible. Thick hair grows from the scalp and some other parts of the body, such as under the armpits and around the genitals. However, certain areas, such as the palms of the hands and the soles of the feet, have no hair at all. In human beings, as in other mammals, hairs around the eyes and ears, and in the nose, serve a protective function. They prevent dust, insects, and other matter from entering these organs. In addition, the eyebrows reduce the amount of light reflected into the eyes.

Among mammals other than human beings, a number of species have special hairs that respond to touch. Many nerves lie around these *tactile hairs,* which are commonly called *whiskers.* Whiskers grow on the lips and cheeks of most mammals, but they also occur on

The parts of a hair

The top diagram shows the parts of a human hair. A hair develops from the cells of the hair bulb. These cells move up to form the root and then the shaft of the hair. The bottom diagram shows the three layers of dead cells that make up a hair shaft.





other parts of the body. These hairs help the animals feel their way through narrow or dark places.

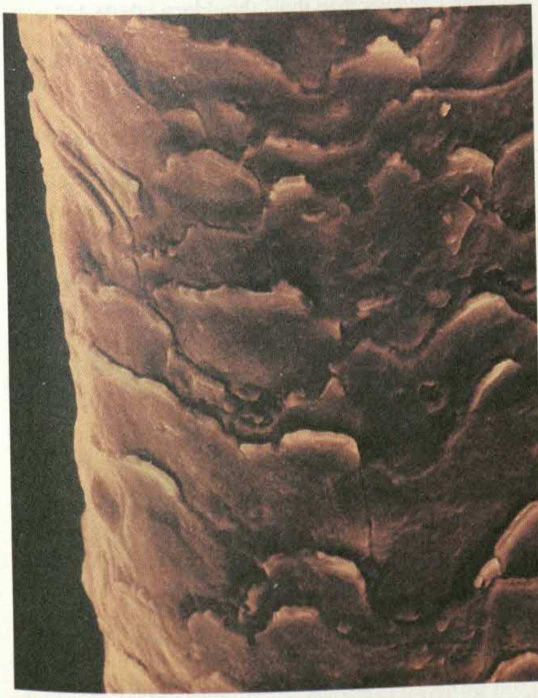
Hair also provides various kinds of protection for animals. The hair colour of many species of mammals blends with their surroundings and helps them hide from their enemies and prey. The quills of porcupines, which also furnish protection against enemies, are a special type of hair. Hair acts as padding against blows and falling objects as well.

Manufacturers use animal hair in making a variety of products. The thick, soft fur that covers some mammals is used for coats and other warm clothing. The woolly fleece of sheep is spun into thread and cloth for such products as blankets, clothing, and rugs. Felt is manufactured by pressing and matting animal hair. Bristles, the short, stiff hair of pigs, are used in making various kinds of brushes.

The structure and growth of hair

The root and shaft. The part of a hair below the surface of the skin rests in a baglike structure called the *follicle.* The *root,* which is the lowest section of a hair, enlarges at the end into a soft, light-coloured structure called the *hair bulb.* Hair develops from the cells of the bulb, which divide rapidly. A structure called the *papilla* projects into the hair bulb at the base of the follicle. It contains connective tissue and blood vessels that supply the blood necessary for the rapidly growing cells.

The cells of the hair bulb move upward as new cells begin to form beneath them. As these cells move higher, they are cut off from their supply of nourishment and start to form a hard protein called *keratin.* This protein is found in the nails, claws, and hoofs of mammals; the scales of reptiles; and the feathers of birds. The formation of keratin is called *keratinization,* and the hair cells die as it occurs.



The shaft of a hair, shown highly magnified, consists of three layers of dead cells. The outer layer, *above,* called the *cuticle,* is made up of flattened cells known as *cuticular scales.*

The keratinization process is completed by the time the hair has risen about a third of the way to the surface of the skin. The part of the hair above where keratinization has occurred is called the *shaft.*

Three layers of dead cells compose the shaft of a hair. The outer layer, called the *cuticle,* consists of flattened cells that are known as *cuticular scales.* Beneath the cuticle lies the *cortex,* a layer of tightly packed, cigar-shaped cells. The cortex contains the *pigment* (colouring matter) that determines the colour of hair. The core of the shaft, called the *medulla,* is made up of loosely packed, boxlike cells.

Glands and muscles. Most hair follicles contain an oil gland called the *sebaceous gland.* This gland secretes oil into the follicle. The oil flows over the hair, lubricating it and keeping it soft.

A muscle known as the *arrector pili* is attached to most hair follicles. When this muscle contracts, it causes a hair to "stand on end." In mammals with heavy coats, hair in this position traps air close to the animal's body, providing extra insulation against the cold. Hair standing on end also makes an animal look larger and more dangerous. When a human being is cold or frightened, the muscles contract and produce little bumps around the hair. These bumps are commonly known as "goose bumps."

Colour and texture. The colour of hair is determined largely by the amount and distribution of a brown-black pigment called *melanin.* Hair also contains a yellow-red pigment that is most visible in people whose hair has little melanin. Most people's hair gradually becomes grey or white as they grow older, because pigment no longer forms.

The texture of hair depends largely on the shape of the hair, which can be seen in cross section under a microscope. Straight hairs have a round shape, and wavy and curly hairs are flat. The flattest hairs are the waviest or curliest.

Cycles of hair growth. The growth of hair in the follicles occurs in cycles. In each cycle, a follicle goes through a growth phase and a resting phase. A hair stops growing during every resting phase, when it is known as a *club hair.* The club hair remains in the resting follicle until the next growing phase. During the growing phase, the club hair is shed as a new hair grows and pushes it out of the follicle.

The length of hair depends on the length of the growing phase of the follicle. The follicles in the human scalp are active for two to six years, and then they rest for about three months. Scalp hairs grow less than 13 millimetres per month. Shorter hairs, such as those in the eyebrows and eyelashes, grow for about 10 weeks and then rest for 9 months.

The human scalp contains an average of about 100,000 hairs. From 5 to 15 per cent of the hairs in the scalp are in the resting stage at any time. A person sheds from 70 to 100 hairs a day from follicles that are in the resting stage.

Many factors affect the growth of hair. They include age, diet, general health, and changes in the seasons. For example, hair grows faster in children than in adults, and it grows faster in summer than during any other season. Cutting or shaving hair on any part of the body does not have any effect on the future growth or texture of the hair.

Disorders of the hair and scalp

Baldness occurs if the follicles on the scalp die and no longer produce new hair. Heredity is the most common cause of baldness. However, other factors, including scalp infections and reactions to drugs or radiation, can also cause it. Baldness caused by heredity is more common in men than in women. Such baldness cannot be cured.

Various factors, including illness and pregnancy, can affect the growth cycles of the hair follicles. The growing phases of the follicles are shorter in such cases, and a large number of club hairs occur. These club hairs may be shed at one time, causing thinning of the hair or even baldness. This type of hair loss is not permanent because new hairs grow after the growing cycles start again.

Excess hair on the face or elsewhere can also be caused by heredity or by certain medical problems. Such hair can be removed by a process called *electrolysis.* This process, in which the papillae are destroyed by an electric needle, prevents new hair from growing. Unwanted hair above the surface of the skin can be removed by the application of a liquid or paste that is called a *depilatory.* However, the root of the hair stays alive, and so the hair grows out again.

Other disorders of the scalp include *dandruff, ringworm,* and *head lice.* Dandruff consists of scales of skin that fall from the scalp. It does not cause a loss of hair unless accompanied by an infection severe enough to damage the follicles. Ringworm is an infection caused by tiny plants called *fungi,* which feed on the keratin in the hair. The hairs break off, leaving bare areas on the scalp. Head lice are insects that suck blood from the scalp and attach their eggs to hairs.

Related articles. For information on the care of the hair, see **Hairdressing.** Other related articles in ***World Book*** include:

Baldness
Beard
Dandruff
Felt
Fur
Louse
Mammal (Skin and hair)
Races, Human (table: Geographical races)
Ringworm
Skin (Hair, nails, and glands)
Wool

Hair hygrometer. See **Hygrometer** (The hair hygrometer).

Hair snake. See **Horsehair worm.**

Hair transplanting. See **Baldness.**

Hairball. See **Cat** (Grooming).

Hairdressing is the art of cutting, setting, arranging, and otherwise caring for the hair. Women and men style their hair to improve their appearance and for comfort. A different hairstyle can alter a person's appearance more than almost any other physical change. Hairdressing can accentuate good features and hide bad ones, or draw attention away from undesirable characteristics. It provides attractive, easy-to-manage hairstyles that meet the needs and desires of the people who wear them.

Hair is the most easily changed physical feature of the human body. Since prehistoric times, people have cut, braided, and dyed their hair and changed it in other ways as well. Professional hairdressers first became common during the 1700's. Today, most women and men depend on hairdressers for such services as cutting, colouring, straightening, and permanent waving. Hairdressers are also known as *hairstylists.* Those hairdressers who work mainly with men's hair are usually called *barbers.*

Hairdressing through the ages

People painted and tattooed their bodies during prehistoric times, and they probably also arranged their hair in various ways. Archaeologists have discovered hairpins and hair ornaments from the New Stone Age, which began about 8000 B.C.

Ancient times. In ancient Egypt, both men and women shaved their heads for cleanliness and relief from the heat. However, they frequently wore long wigs made of braids or spiral curls stitched to a woven foundation. These wig styles lasted for centuries.

In ancient Greece and Rome, most people wore a narrow band called a *fillet* around their heads to hold their hair in place. Fashionable men frizzed their hair and powdered it with gold dust. Women braided, curled, or tied their hair into fancy styles. Many women bleached their hair blond.

Two early Germanic peoples, the Angles and the Saxons, dyed their hair blue, green, or orange. The ancient Gauls, who lived in France, coloured theirs red.

The Middle Ages began in the late 400's and lasted until about the 1400's. Hairstyles changed little during this period. Most men wore medium-length hair that reached no lower than their shoulders. Priests and monks had a shaved patch called a *tonsure* on the crown of the head. Girls and unmarried women wore their hair loose. Married women covered theirs with a veil or a hoodlike covering. Sometimes they plucked or shaved the hair at the hairline to make the forehead seem higher.

The Renaissance. Women wore many hairstyles during the Renaissance, which began in Italy about 1300 and spread throughout Europe during the 1400's and 1500's. Some had long braids that fell to their knees. Others drew their hair back into a large roll called a *chignon* at the back of the head. A hairstyle called *Venus' hair* featured thick strands, stiffened with gold lacquer, that seemed to flow from the head. Blond hair was extremely fashionable, and women spent long hours in the sun to bleach their hair.

Most men wore short or shoulder-length hair, and many had a fringe covering the forehead. King Henry VIII of England ordered Englishmen to wear short hair in imitation of French noblemen.

The 1600's. Most men of the 1600's had long, flowing curls. Many wore a side curl called a *lovelock,* which was longer than the other curls and tied with a ribbon. During the Civil War in England (1642-1649), the chief opponents of King Charles I were the Puritans. They were called *Roundheads* because they had their hair cut close to their heads. Their short haircuts distinguished them from the king's supporters, a group called the *Cavaliers,* who had long hair. King Louis XIII of France started a fashion for men's wigs after he lost his own

Detail of an Egyptian limestone relief of *Amenmes and His Wife* (about 1300 B.C.); The Louvre, Paris

Ancient Egyptians wore long wigs of spiral curls, such as those worn by this nobleman, *left,* and his wife, *right.* The curls were made of human hair, palm-leaf fibres, or wool.

hair. Many men wore huge, curled wigs called *periwigs.*

During much of this period, women wore their hair piled high on their heads. However, curls that fell to the shoulders were fashionable in the mid-1600's.

The 1700's. Elaborate hairstyles became popular with both women and men during the 1700's. Women's hairdos were extremely high and had to be supported by small cushions and wire frames. Many styles measured more than 60 centimetres high and had floral, operatic, or poetic themes. Women covered their hair with white or pastel powder and decorated their hairdos with feathers, jewels, tassels, or other ornaments. Sometimes they did not wash or comb their hair for several weeks because the styles were so complicated. Professional hairdressers became common to help create and care for such hairdos.

Men covered their hair with powdered wigs. The most popular wig styles were smaller than those of the 1600's. A style called a *tie wig* was pulled back and tied with a short ribbon. The ends of a *bag wig* were covered with a silk bag.

The 1800's brought simpler hairstyles. Fashionable styles for women included plaits, topknots, and heavy coils of hair over each ear or at the nape of the neck. Long, smooth curls shaped like sausages were stylish during the 1840's. In the 1870's, a French hairdresser named Marcel Grateau invented the *marcel wave,* a series of deep, soft waves made with heated tongs. Another French hairdresser, Alexandre F. Godefroy, invented a hairdrier about 1890. Godefroy's clients wore a bonnetlike covering that was attached to the chimney pipe of a gas stove. Beginning in the 1890's, fashionable American women wore their hair up in a soft style called the *Gibson girl* look. This style was made popular by the American artist Charles Dana Gibson.

Men wore their hair short during the 1800's and dressed it with hair oil, particularly *Macassar oil.* This type of oil became so popular that protective coverings called *antimacassars* were made for chairs and sofas.

The 1900's. Hairdressers of the 1900's developed new processes for curling the hair. Charles L. Nessler, a German-born hairdresser, invented the permanent wave about 1905. Nessler first applied a borax paste and then wound the hair on electrically heated curlers. The permanent-wave treatment took up to 12 hours and was very expensive.

During the 1920's, many women cut their hair in a short style called the *bob* and had it permanent-waved. The *cold wave,* a permanent wave that did not require heat, was developed in the 1930's. A cold wave took about two hours and was quite cheap.

During the 1940's, many women wore the *sheepdog,* or *Veronica Lake,* style. This hairstyle was made popular by Veronica Lake, an American film star who had long hair that covered one eye. In the 1950's, large numbers of women began to colour their hair or *highlight* their hair—that is, bleach a few strands. The puffy appearance of *bouffant* hairdos was stylish in the late 1950's and early 1960's. To give their hair the necessary fullness, women combed it from the ends toward the scalp in

Marble sculpture (about 100 B.C.); Museo Civico, Bologna, Italy

A fillet was a band worn by ancient Greeks and Romans to hold their hair in place. This sculpture is probably of the Greek goddess Athena.

Detail of *Lady in Yellow* (about 1465) by Alesso Baldovinetti; National Gallery, London

A woman of the 1400's plucked or shaved her hair at the hairline to make her forehead seem higher. Blond hair was extremely fashionable.

Detail of a painting (about 1700); Musée des Beaux-Arts, Orleans, France

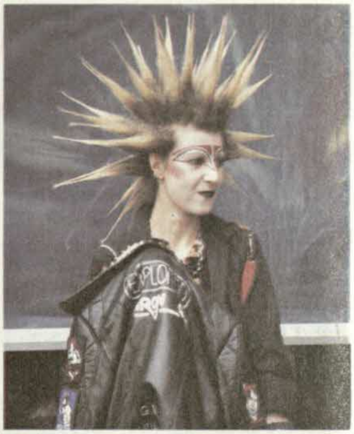
A periwig was a huge, curly wig worn by men of the 1600's and 1700's. The wig might be unpowdered, like this one, or covered with white powder.

Detail of *Marie-Thérèse of Savoy* (1700's) attributed to Antoine Callet

A towering hairdo of the mid-1700's was supported by a wire frame. Such hairstyles were decorated with flowers, jewels, or other ornaments.

The *Gibson girl* look, a soft, puffy hairstyle of the 1890's, was created by the American artist Charles Dana Gibson.

The crew cut, in which a man's or boy's hair is cut very short and brushed upward, was popular during the 1950's.



Punk styles moulded hair into spikes and other shapes. The hair was also dyed unnatural colours.

a process that is called *backcombing* or *teasing.*

Men wore their hair short throughout the early and mid-1900's. During the 1920's, many young men wore *patent leather hair,* which they slicked down with oil in the manner of the American film star Rudolph Valentino. During the 1950's, some men wore a *crew cut,* in which the hair was cut extremely short and combed upward to resemble a brush. Other men of the same period wore a *duck's arse.* This style left the hair long on the sides and swept it back, so that it looked somewhat like a duck's arse. During the 1960's, young men copied the haircuts of the Beatles, a British pop music group, who wore long hair that covered the forehead.

In the late 1970's, another movement in pop music was known as punk. Followers of the punk movement wore their hair in outrageous ways which announced their break away from everything traditional. Their style was characterized by spiky hair moulded with soap, egg white, or glue and dyed in vivid colours.

A number of *unisex* styles, which were fashionable for both sexes, appeared during the 1960's and 1970's. Many men and women wore their hair long, either straight or curly; or in a bushy style called the *Afro.* Partly as a result of such styles, more men visited hairdressers for permanent waves and other services. Many hairdressers began to style both men's and women's hair.

African styles continued to influence black hairdressing in the 1970's. Rastafarians, who wear *dreadlocks* (long, unkempt plaited hair), were to be seen in many major cities in Europe and North America. Other, more carefully plaited styles became popular. One such is known as *cornrows,* in which the hair can be plaited into a variety of patterns across the scalp. One African style uses threaded beads and other ornaments in the hair.

Caring for the hair

Clean, healthy hair results from regular brushing and shampooing, and a well-balanced diet. Brushing removes dirt and tangles and spreads the natural scalp oils through the hair. Dry hair should be washed about once a week. Oily hair may need a daily washing.

Most people handle the daily care of their hair at home. They visit a hairdresser only for haircuts, colouring, straightening, or permanent-waving. Many styles need no setting and can be blown dry with a hand drier or allowed to dry naturally.

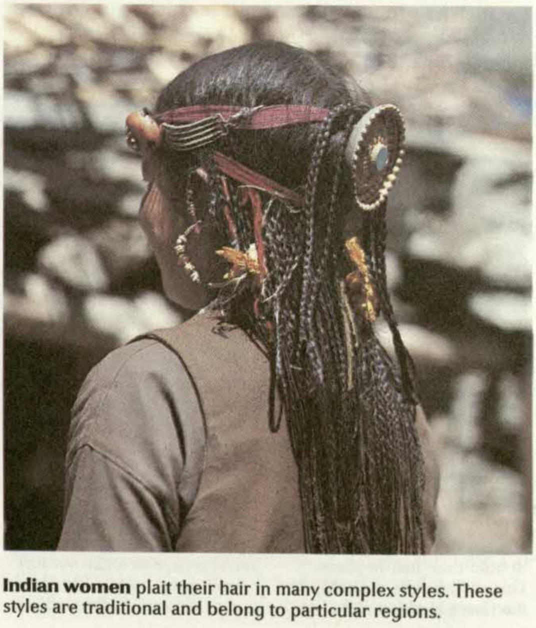
Related articles in ***World Book*** include:

Barber
Beard
Clothing (Clothing through the ages; pictures)
Cosmetics
Dandruff
Hair
Wig

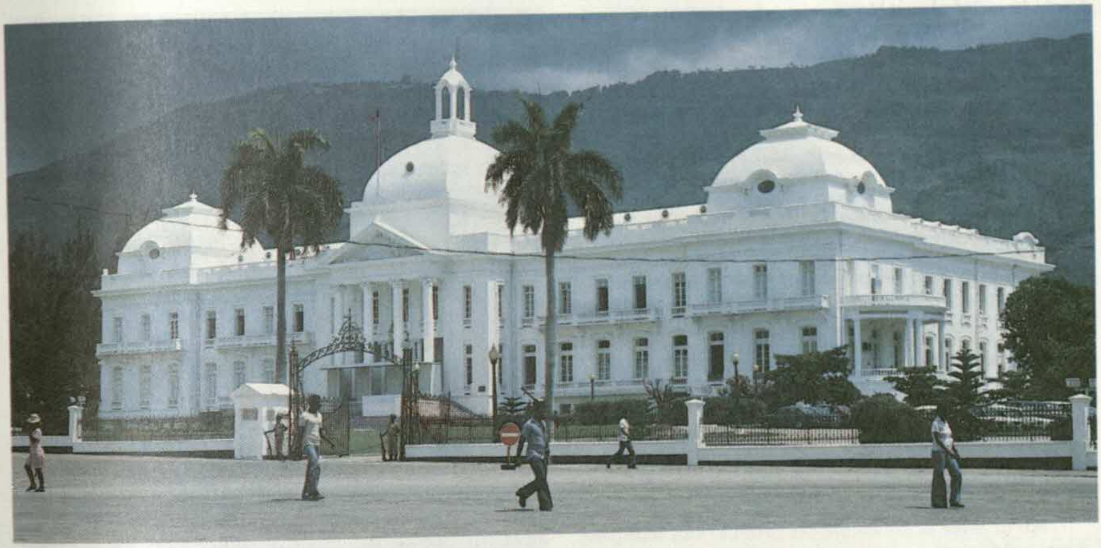
Hairstylist. See Hairdressing.

Hairworm. See Horsehair worm.

Hairy-nosed wombat. See Wombat.



Indian women plait their hair in many complex styles. These styles are traditional and belong to particular regions.



The National Palace in Port-au-Prince is the official home of the president of Haiti. It also houses some of Haiti's governmental offices. Haiti has been an independent nation since 1804. But during most of its history, the country has been ruled by dictators.

Haiti is an independent country in the Caribbean Sea. It occupies the western third of Hispaniola, the second-largest island in the West Indies. The rest of Hispaniola is occupied by the Dominican Republic. For information about Hispaniola and its location, see **Hispaniola.** See also **Dominican Republic.**

Haiti is a mountainous country. Its name, which means "Land of Mountains," comes from the language of the Arawak—the people who were living on the island when Christopher Columbus arrived there in 1492. The capital of Haiti, Port-au-Prince, lies on the southern coast of the country. See **Port-au-Prince.**

Government

Haiti has had a troubled history, marked by military *coups* (seizing power by force). For example, a military regime suspended the Constitution in 1991 and ruled until 1994.

The Constitution, approved in 1987 by a majority of the voters, specifies that Haiti is a republic in which the ruling power is shared between a president elected by the people and a *bicameral* (two-chamber) lawmaking body, or *legislature.* The legislature consists of a 77-member Chamber of Deputies and a 27-member Senate. Under the Constitution, the president holds office for five years, and no president may serve two consecutive terms. The prime minister, selected from the majority party in the legislature by the president, chooses his *Cabinet* (chief ministers) in consultation with the president.

People

Population and ancestry. For Haiti's total population, see the *Facts in brief* table with this article. About 95 per cent of the people of Haiti are of African origin. The other 5 per cent are *mulattoes* (people of mixed African and European descent). A few Americans, Asian Indians, Europeans, and Syrians also live there.

Haiti is one of the most crowded countries in the Caribbean. The average population density is more than 243 people per square kilometre. The population is densest in Haiti's towns, but some rural areas may have a density of only 2 to 4 people per square kilometre.

Language. The official language of Haiti is French. Educated Haitians, accounting for about 10 per cent of the population, speak and write French. The remainder use Haitian *creole,* a mixture of French and African language. About 7 per cent of all Haitians are bilingual in French and Haitian creole. Near the Dominican Republic, people speak a Spanish-based creole. In Haiti's major urban areas, many people understand and speak English.

Education. The state and the Roman Catholic Church, together with some other religious bodies, provide education to children free of charge. Children aged from 6 to 13 years must attend primary school by law. Secondary education lasts from the age of 13 to the age of 18. Because of a shortage of teaching materials and equipment, schools must often charge students tuition and laboratory fees. This prevents many poor Haitians from receiving a school education. Only about 40 per cent of children of primary-school age and 15 per cent of children of secondary-school age go to school. Only 38 per cent of Haitians can read and write.

The Université d'Etat d'Haiti (the State University of Haiti) is located in Port-au-Prince. In addition, Haiti has more than 20 vocational centres and schools of domestic science offering post-secondary courses.

Way of life

About 70 per cent of Haiti's total population live in the rural areas of the country. Most of the people in these areas are smallholders growing enough food for themselves and their families on farms usually no more than 8,000 square metres—about the size of a soccer pitch. Apart from growing crops, some people may also keep

Facts in brief about Haiti

Capital: Port-au-Prince.
Official language: French.
Area: 27,750 km². *Greatest distances*—east-west, 290 km; north-south, 217 km. *Coastline*—1,081 km, including offshore islands.
Elevation: *Highest*—Pic de la Selle, 2,677 m above sea level. *Lowest*—sea level.
Population: *Estimated 1996 population*—7,328,000; density, 243 people per km²; distribution, 70 per cent rural, 30 per cent urban. *1982 census*—5,053,792. *Estimated 2001 population*—8,123,000.
Chief products: *Agriculture*—bananas, coffee, sugar cane, sweet potatoes. *Manufacturing*—textiles, machinery. *Mining*—marble, limestone.
National anthem: "La Dessalienne" ("Song of Dessalines").
Flag: The dark blue top half of the *national flag,* flown by the people, stands for the blacks of Haiti; the red bottom half represents its mulattoes. In the centre of the *state flag,* used by the government, is the Haitian coat of arms. See **Flag** (picture: Flags of the Americas).
Money: *Currency unit*—gourde. One gourde = 100 centimes.

chickens, a goat, or a pig. The farms in the mountainous regions are not highly productive, partly because the soil is barely fertile. However, some farmers in these regions may grow more than they need and sell the surplus in the local village market.

Housing. Poor Haitians in rural areas live in thatched huts with earth floors. The huts are made of *wattle and daub,* in which a plaster of mud is laid over a wooden frame. Many Haitians migrate to the towns and cities to seek work and better living conditions. Most remain unemployed or find only low-paid jobs, so they have to live in slum areas.

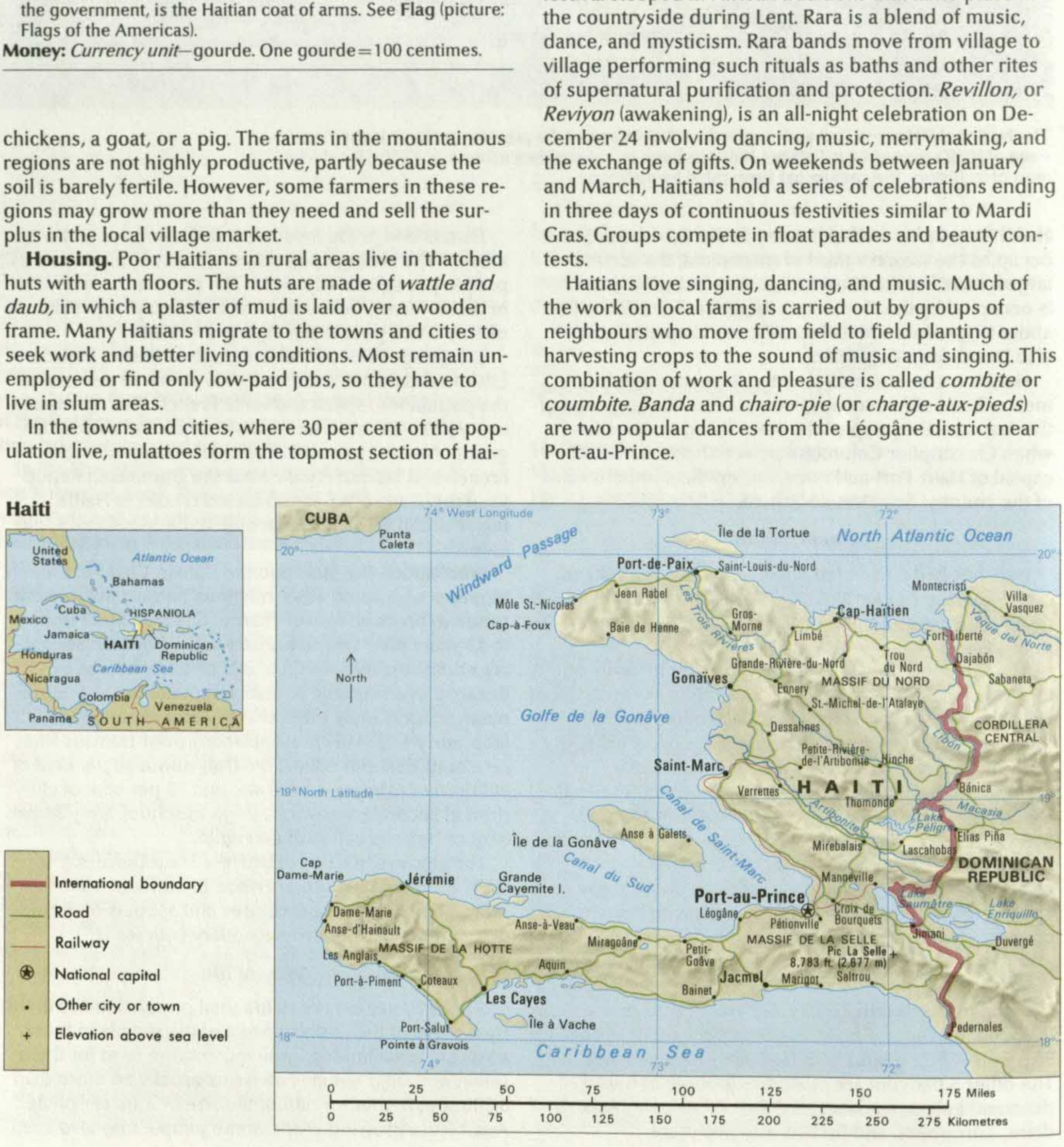
In the towns and cities, where 30 per cent of the population live, mulattoes form the topmost section of Haitian society. They are usually wealthy and well educated. Mulattoes own and operate most of the business in urban Haiti. They also own the larger sugar plantations and live in large, luxurious houses, decorated with French art and furniture.

Food. The chief foods eaten by poorer Haitians are based on the country's main crops. These include maize, beans, cassava, rice, bananas, *plantains* (a variety of banana), and yams. Haitians make flour and bread from cassava. Pigs are reared for pork and cooking oil. Haitians who are too poor to buy a stove for cooking use a *ratio,* a cooking appliance similar to a barbecue grill, made from scrap metal.

Culture. Haiti's military governments made it difficult to celebrate Haitian festivals. But the people of Haiti have managed to maintain a few. One is *Rara,* a unique festival steeped in African traditions that takes place in the countryside during Lent. Rara is a blend of music, dance, and mysticism. Rara bands move from village to village performing such rituals as baths and other rites of supernatural purification and protection. *Revillon,* or *Reviyon* (awakening), is an all-night celebration on December 24 involving dancing, music, merrymaking, and the exchange of gifts. On weekends between January and March, Haitians hold a series of celebrations ending in three days of continuous festivities similar to Mardi Gras. Groups compete in float parades and beauty contests.

Haitians love singing, dancing, and music. Much of the work on local farms is carried out by groups of neighbours who move from field to field planting or harvesting crops to the sound of music and singing. This combination of work and pleasure is called *combite* or *coumbite. Banda* and *chairo-pie* (or *charge-aux-pieds*) are two popular dances from the Léogâne district near Port-au-Prince.

Haiti



The gateway to the Iron Market in Port-au-Prince is framed by Moorish-style turrets. In the market, merchants sell food, clothing, and many other items in indoor and outdoor stalls.

One of the most important visual arts in Haiti is wood carving. Mural painting and sculpture using oil drums are major art forms in Haiti.

Religion. About 80 per cent of Haitians are Roman Catholics. Roman Catholicism is the official religion of Haiti and receives financial support from the government. Haiti also has followers of Protestant religions, including Baptists, Lutherans, and Episcopalians.

The main folk religion is *voodoo,* which was taken to Haiti by African slaves. The followers of voodoo believe in many gods, such as a god of war or a god of agriculture. They further believe that invisible spirits inhabit trees, water, and other natural environments in the countryside. These spirits are also considered to be gods, all of which are worshipped by followers of voodoo. Adherents also believe that the spirits of their dead ancestors, which they also worship, can communicate with the living.

Many Haitians believe that by performing certain voodoo ceremonies they can be *possessed* (taken over) by spirits. Often in these ceremonies, the *houngan* (voodoo priest) makes certain designs on the ground with flour or some other white powder. In and around these designs, the voodoo worshippers dance, sing, chant, and beat drums in an increasingly frenzied way until one of them is possessed by a god. The possessed person usually falls to the ground in a trance and may twitch with convulsive motions.

The followers of voodoo believe that many spirits are evil. They try to neutralize the harmful effects of the spirits by communicating with them. Through the use of certain herbs, oils, and powders, followers of voodoo believe that they can protect themselves and their property from evil.

The belief in voodoo runs deep in Haitian society. Adherents believe that voodoo can be used to cast an evil spell on an enemy. But voodoo is also thought to be capable of bringing good fortune. Many people use voodoo practices to help them find a husband or wife. Alternatively, they may use voodoo to help them get rid of a spouse. In the past, some of Haiti's political leaders have exploited the Haitians' belief in voodoo to control the population. For further information about voodoo, see **Voodoo.** See also **West Indies.**

Land

Two chains of rugged mountains cross the northern and southern parts of Haiti to form two extensive peninsulas at the western end of the country. The northern peninsula juts about 160 kilometres into the Atlantic Ocean and the southern peninsula extends about 320 kilometres into the Caribbean Sea. A gulf, Golfe de la Gonâve, and an island, Île de la Gonâve, lie between the two peninsulas.

The two major mountain ranges of the southern peninsula are the Massif de la Hotte in the west and the Massif de la Selle. The Massif de la Selle reaches a height of 2,677 metres on the Pic de la Selle. In the north, the most extensive mountain system is the much lower Massif du Nord.

The most important lowland regions of the country are the Plaine du Nord (Northern Plain), the Central Plateau, Plaine de l'Artibonite (Artibonite Plain), and the Cul-de-sac. There are also scattered narrow coastal plains and pockets of level land in the mountains. About 100 rivers and streams flow from the mountains to the coast. The largest of these are the Artibonite River and the Trois River.

Several varieties of drought-resistant plants grow on the dry plains. The slopes that do not face the wind support cactuses and several varieties of tall grass. Some upland areas contain pine, mahogany, rosewood, satin wood, lignum vitae, fruit trees, cacao, coffee, and coconut.

Crocodiles, lizards, iguanas, flamingos, pigeons, ducks, and guinea fowl are common. No other large wild animals live on the island.

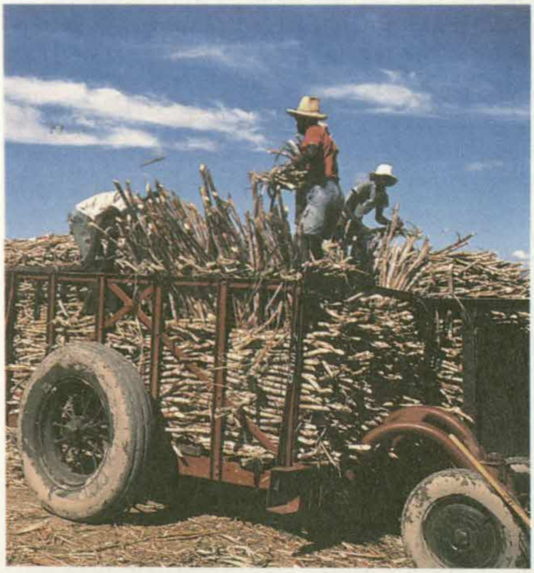
People farm wherever they can. In some areas, they grow crops on slopes so steep that the farmers must anchor themselves with rope to keep from sliding down the hillside. Cultivation of these slopes has caused *erosion* (wearing away) of the soil.

Climate

Haiti has a tropical climate with mild temperatures that range from 21 ° to 32 °C along the coasts and from 10 ° to 24 °C in the mountains. The rainy season is from May to November. Annual average rainfall varies from 250 centimetres in the tropical forests in the northern mountains to about 50 centimetres in the sheltered Artibonite Plain.

Economy

Agriculture is the major economic activity in Haiti. It employs 67 per cent of the labour force and accounts for 33 per cent of *Gross Domestic Product* (GDP). The GDP is the total value of all the goods and services a country produces. The chief sources of commercially grown crops are the plantations owned by mulattoes. Principal agricultural cash crops are bananas, coffee,



Sugar cane is one of Haiti's major crops. These rural labourers are loading the cane onto trucks for shipment to a mill, where it will be refined. Haiti exports refined sugar to the United States, France, and other countries.

sugar cane, and sweet potatoes. Mangoes, oils for pharmaceuticals and cosmetics, and cocoa beans are important agricultural exports. Maize, rice, plantains, cassava, citrus fruit, and vegetables are for local consumption.

Mining, manufacturing, and construction contribute an estimated 23 per cent of Haiti's GDP but employ 9 per cent of the labour force. The country's quarries produce marble, limestone, and certain clays. In addition, there are rich deposits of *bauxite* (an ore of aluminium) and copper, but these are largely unexploited. Food processing and the production of textiles and machinery account for 12 per cent of Haiti's GDP and employ 7 per cent of the labour force.

The United States is Haiti's chief trading partner. Haiti also trades with France, Japan, Canada, Italy, Germany, and the Dominican Republic.

Transportation and communication. Port-au-Prince and Cap Haïtien are the principal sea ports. Haiti's international airport, situated just outside Port-au-Prince, is serviced by major airlines within the Caribbean and the United States. Smaller airports are located at Cap Haïtien, Jeremie, Port-de-Paix, Jacmel, and Les Cayes. However, flights into and out of Haiti are irregular. Haiti has an estimated 5,000 kilometres of very poor roads. There are 29 radio stations, one television station, and 25 newspapers and periodicals in Haiti, but the media is censored. Under the military government, journalists suffered intimidation and some were killed.

History

Christopher Columbus arrived in Hispaniola on December 6, 1492. One of his ships, the *Santa Maria,* ran aground near the present-day city of Cap Haïtien. Columbus' crew used the ship's timber to build a fort, which Columbus named Fort Navidad. Some of the crew stayed to hold the fort when Columbus sailed on. The Arawak, who already lived on the island, destroyed the fort and killed the men.

Columbus discovered gold in the eastern part of Hispaniola, and because of this the Spaniards largely neglected the mountainous western end of the island. Hispaniola's Arawak population were virtually wiped out by disease and overwork in the gold mines by about 1530. French, English, and Dutch settlers then took over the abandoned northern and western coasts of Hispaniola.

Buccaneers used the small island of Tortuga off the northwestern coast of Hispaniola as a base and attacked ships carrying gold and silver to Spain. The Spaniards failed to drive out the buccaneers and in 1697, Spain recognized French control of the western third of the island.

France named its new colony Saint Domingue. French colonists brought in African slaves and developed big plantations of coffee, cocoa, cotton, indigo, and sugar cane. By 1789, there were eight times as many slaves (nearly 435,000) as there were colonists. The colony prospered, and became more important to France than its colony in Canada.

The French and mulatto landowners enjoyed great wealth and comfort while their slaves endured hardship and maltreatment. In 1791, the slaves rebelled and destroyed plantations and towns. Toussaint L'Ouverture, a former slave, took control of the government and restored some order to the country. Napoleon I sent an army to restore colonial rule. The army captured Toussaint by a trick and sent him in chains to France, where he later died. However, many of the French soldiers caught yellow fever and died in Saint Domingue, and the rebels defeated the weakened French army in 1803. On Jan. 1, 1804, General Jean Jacques Dessalines, the leader of the rebels, proclaimed the colony an independent country named Haiti.

Dessalines became the nation's first leader. When he was killed in 1806, two other generals, Alexandre Pétion and Henri Christophe, struggled for power and divided the country between themselves. Jean-Pierre Boyer replaced Pétion in 1818 and reunited the country after Christophe committed suicide in 1820. In 1822, Boyer took control of the Spanish colony in eastern Hispaniola. Haiti ruled it until the colony revolted in 1844. During the next 70 years, 32 different men ruled Haiti. Unrest spread throughout the country.

From 1915 to 1934, Haiti came under the control of the United States. The occupying forces from the United States restored order, made Haiti pay its international debts, and gave the country stronger government. The United States built roads, schools, and hospitals, and set up a sanitation programme that eliminated yellow fever in Haiti.

Following the U.S. occupation, Haiti's next two presidents encouraged foreign companies to invest in Haiti. But the upper-class mulattoes gained most of the benefits from these investments. After World War II (1939-1945), a series of repressive dictatorships again arose to stifle Haiti's freedoms.

The worst of these dictatorships were those of François Duvalier and his son and successor Jean-Claude. They harshly governed Haiti from 1957 to 1986. Seven years after being elected to power in 1957, François Duvalier declared himself president for life. He controlled the army and founded the hated *Tontons Macoutes* (Bogeymen), a private security force set up to enforce his policies. The *Tontons Macoutes* were responsible for much terrorism and murder in Haiti.

Jean-Claude Duvalier came to power following his father's death in 1971. He also declared himself president for life and ruled as a dictator. During the 1970's, many Haitians left the country seeking refuge abroad from the military and the secret police.

In 1986, the Haitians rebelled and ousted Jean-Claude Duvalier. He went into exile in France. Lieutenant General Henri Namphy, the commander of Haiti's armed forces, became head of the government. A constitution adopted in March 1987 provided for presidential and national assembly elections by the people. In January 1988, after terrorists had disrupted earlier elections by violence, the voters elected a parliament and a civilian president, Leslie Manigat. In June 1988, Namphy overthrew the government and seized power.

In September 1988, officers of Haiti's Presidential Guard seized power from Namphy. Lieutenant General Prosper Avril declared himself president. In March 1990, Avril resigned after protests against his rule. Supreme Court Justice Ertha Pascal-Trouillot became temporary president.

In December 1990, the Haitian people elected Jean Bertrand Aristide, a Roman Catholic priest, as president. A new parliament was also elected. But in September 1991, military leaders under General Raoul Cedras overthrew Aristide, and he fled the country. The international community later began a trade boycott against Haiti designed to force Aristide's return to power, but without success. On May 11, 1994, Emile Jonassaint was sworn in as a provisional president with the support of the military. The international community did not recognize Jonassaint. The United Nations voted for an extended trade ban against Haiti.

Meanwhile, after the coup, thousands of Haitians tried to flee to the United States in small boats. The U.S. government forced most of them to return to Haiti. In May 1994, the U.S. government changed its policy and agreed that all Haitian boat people should receive an *asylum hearing,* a legal process to determine whether they had legitimate cause to seek sanctuary in the United States. But in the face of overwhelming numbers of refugees, the U.S. administration reversed this policy again in July, banning further resettlement of Haitian refugees. In August, the UN authorized an invasion of Haiti to impose order and restore democracy. In a last-minute compromise brokered by former U.S. President Jimmy Carter, an invasion was halted and the junta agreed to step down. In September, some 15,000 U.S. troops arrived in Haiti to maintain order during the return to democracy and the reinstatement of Aristide.

Related articles in ***World Book*** include:

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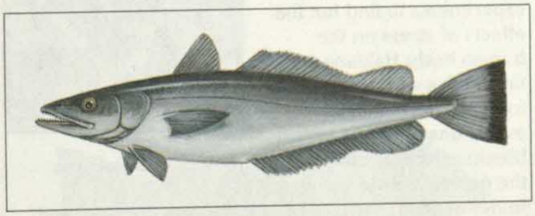
West Indies

Hajj, also spelled *hadj,* is a holy pilgrimage to Mecca, the holy city of the Islamic religion. The Kaaba, the most sacred shrine of Islam, is in Mecca, Saudi Arabia, and is the chief goal of the pilgrimage. The Islamic religion requires every Muslim to make this journey at least once, if possible. Going on the hajj is one of the five *pillars* (duties) of Islam. The hajj includes a number of ceremonies that last several days. Muslims believe a person who makes the hajj secures great religious merit. Such a person is called a *hajji* and is held in esteem. See also **Kaaba; Mecca; Muslims.**

Haka. See **Maori.**

Hake is the name of a group of food fish closely related to the cod. Hake live in shallow to deep ocean waters. They inhabit most coastal areas of the Atlantic Ocean and the eastern Pacific Ocean.



A hake has two fins on its back and a long fin on its underside. Hake feed on shrimp, squid, and even other hake.

Commercial fishing crews use a variety of techniques to catch hake. One of the most efficient ways includes a *trawl* (large, cone-shaped net). Some hake are sold either fresh or frozen. Others are used as animal feed.

True hake have two fins on the back with a notch in the second fin, and a long fin on the underside. These fish vary in colour. Many are brown to grey on top and silver to white on the belly and sides. Some true hake reach about 1.2 metres in length and weigh up to 23 kilograms. But most weigh less than 3.5 kilograms. Some species of fish that are commonly called hake belong to the cod family. These fish may have fins on the back or underside that extend into long, narrow feelers.

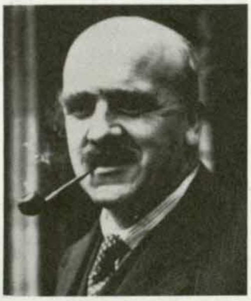
Hake feed on a variety of prey, such as shrimp, squid, and even other hake. They swim in *schools* (groups) when hunting.

Scientific classification. Most scientists classify true hake in the merluccid hake family, Merlucciidae. Others classify them in the cod family, Gadidae.

Hakluyt, Richard (1552?-1616), was a British clergyman and geographer. His *Principall Navigations, Voiages and Discoveries of the English Nation* (1589) contained eyewitness accounts and other records of more than 200 voyages.

Hakluyt's family came from what is now the county of Hereford and Worcester, England. He was educated at Westminster School, London, and Oxford University. Hakluyt was a collector of trade documents. A book he wrote on American discoveries (1582) led to his appointment as chaplain to the English ambassador in France (1583-1586). He became archdeacon at Westminster Abbey in 1602. In 1609, he published his translation of the Portuguese explorer Hernando de Soto's travels.

Halcyon days, according to sea tradition, is the two-week period of calm weather before and after the shortest day of the year, about December 21. People often use the term to refer to a time of peace or prosperity. The phrase is taken from *halcyon,* the name the ancient Greeks gave to the kingfisher. According to folklore, the halcyon built its nest on the surface of the ocean, and was able to quieten the winds while its eggs were hatching.



J. B. S. Haldane

Haldane, J. B. S. (1892-1964), was a British scientist who made many contributions in the fields of mathematics, physiology, biochemistry, and biology. His father, a physiologist, used him as a guinea pig in experiments to find out the effects of stress on the human body. Haldane continued this work. He founded the mathematical evolutionary theory and, in biochemistry, he studied the genetic colour varieties found in plants. He was born in Oxford, England, and named John Burdon Sanderson Haldane.

Hale, George Ellery (1868-1938), was an American astronomer who pioneered the development of instruments for studying the sun. He also planned the construction of several giant telescopes, including the Hale Reflecting Telescope at the Palomar Observatory near San Diego, California, U.S.A. The mirror of this instrument has a diameter of 508 centimetres.

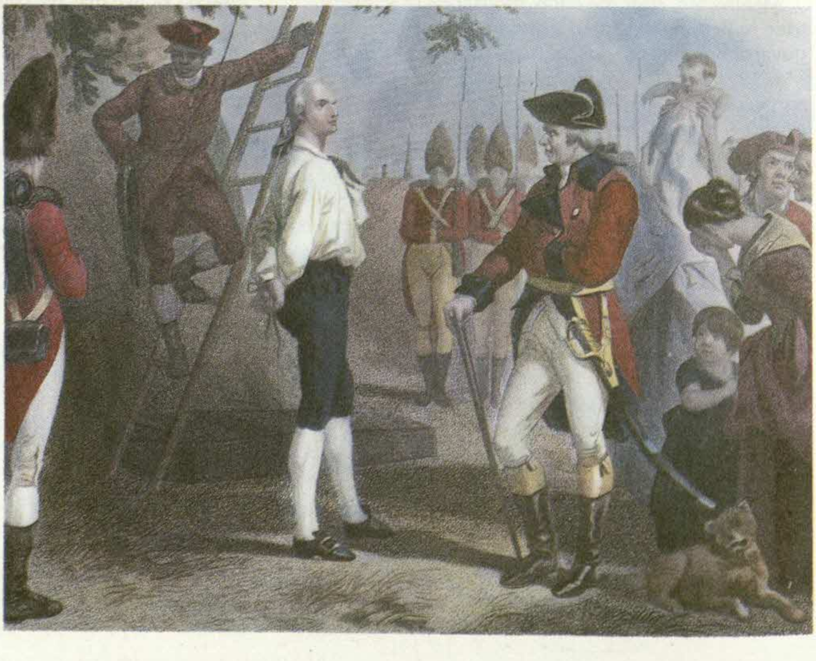
Hale was born in Chicago, Illinois, U.S.A., and graduated from the Massachusetts Institute of Technology. In 1891, he introduced the *spectroheliograph,* an instrument that enables astronomers to photograph the surface of the sun with light of a single wavelength. Photographs made with it reveal the distribution on the sun's surface of such elements as calcium, hydrogen, and iron. Hale also made important discoveries about sunspots. He proved that these dark areas on the sun have strong magnetic fields. In 1895, Hale founded the *Astrophysical Journal,* which became the leading journal for astronomers. He founded and was first director of the Yerkes Observatory in Wisconsin and, later, the Mount Wilson Observatory in California, U.S.A.

Hale, Nathan (1755-1776), was an American patriot of the American Revolution. He was hanged by the British as an American spy when he was only 21 years old. His conduct and his courage made him one of America's most-remembered heroes.

Hale was born in Coventry, Connecticut, U.S.A. He took advantage of opportunities for education. He prepared for college and learned the classics. In 1769, Hale entered Yale College. After graduation in 1773, he taught in a school for a year at East Haddam, Connecticut. He then moved to New London, Connecticut.

The American Revolution. Although Hale was highly successful in his teaching, he was also deeply concerned about American rights. In July 1775, he received a lieutenant's commission from the Connecticut assembly, and helped in the siege of Boston. When the British forces evacuated Boston and entered the New York area, Hale, along with other patriot soldiers, went there to meet the new threat. By this time, he had become a captain in the Continental Army. Hale's resourceful leadership, especially in capturing a supply-loaded vessel from under the guns of a British warship, won him a place in a select fighting group called the Rangers. The Rangers were known for their daring leadership and fighting qualities in dangerous missions.

The fateful mission. Unknown to Hale or anyone else, the time had come for a dramatic moment of the American Revolution. General George Washington asked the Rangers' commander to select a man to pass



Captain Nathan Hale was executed in New York City. Major Cunningham, who stands facing Hale, denied his last request for a Bible and destroyed a letter Hale had written.

through the British lines to obtain information on the British position. The commander called for a volunteer. Hale agreed to undertake the mission.

Disguising himself in civilian clothes as a Dutch schoolmaster, Hale succeeded in crossing the British lines. He obtained the information that Washington requested. But as Hale returned to the American lines on Sept. 21, 1776, he was captured by the British.

Hale was taken before General William Howe, the British commander. Howe saw that Hale was out of uniform and condemned him to hang the next day as a spy. With remarkable calmness of mind and spirit, Hale prepared for his execution. Before the hanging he made a speech. Historians are not sure what Hale really said. According to tradition, he ended his speech with the inspiring words, "I only regret that I have but one life to lose for my country."

There are several Hale monuments. A boulder marks *Halesite* near Huntington, New York, where it is believed Hale was captured. A Nathan Hale Homestead stands in South Coventry, Connecticut.

Hale, William. See **Rocket** (History).

Hale Observatories. See **Mount Wilson Observatory; Palomar Observatory.**

Halevi, Judah (1085-1141?), was one of the greatest Hebrew poets of the Middle Ages. His poetry included both national and religious songs, and dealt with the suffering and hopes of the Jewish people. Many of his hymns to Zion (the land of Israel), called "Zionids," are still read in Jewish religious services. He was also a doctor and a religious philosopher, His most important philosophical work was *Sefer ha-Kuzari,* or *al-Khazari,* an eloquent defence and profound explanation of Judaism. Halevi was born in Toledo, Spain.

See also **Hebrew language and literature** (Medieval works).

Haley, Alex (1921-1992), was an American author who became famous for his book *Roots: The Saga of an American Family* (1976). In the book, Haley combined fact and fiction as he described the history of his family, beginning in the mid-1700's in Africa. *Roots* tells how Haley's ancestor Kunta Kinte was kidnapped in The Gambia in 1767 and taken to America as a slave. It follows the struggles of Haley's family in America as slaves and later as free people.

Haley spent 12 years researching *Roots.* His fame grew after an eight-part dramatization of *Roots* appeared on television in the United States in 1977, and then elsewhere. The final episode attracted one of the largest audiences in American television history. That same year, Haley received the Spingarn Medal and a special citation from the Pulitzer Prize Board for his book.

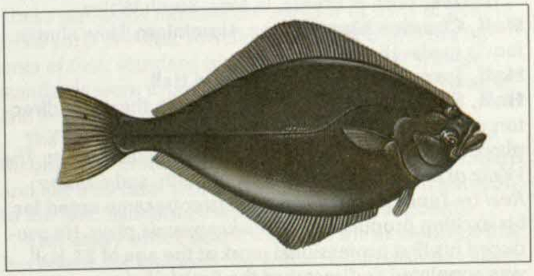
Alex Palmer Haley was born in Ithaca, New York, U.S.A., and grew up in Henning, Tennessee, and other Southern communities. He served in the Coast Guard from 1939 to 1959 and began to write articles and short stories during that period. Haley edited *The Autobiography of Malcolm X* (1965).

Alex Haley

Half-life. See **Radioactivity** (Half-life).

Halfway house. See **Prison** (Reforms in the 1900's).

Halibut is one of the largest and most important of the flatfishes. Its name comes from the word *holy,* and refers to the fact that it was once widely used as food on Christian holy days. A cold-water fish, the halibut belongs to the flounder group, and has the characteristic flat body, with both eyes on the same side of the head. Its eyes lie on the right side, which is dark brown. The left side is white. Halibut can be found in all northern seas. They are among the largest of the world's true bony fishes. Some female halibut weigh as much as 180 kilograms.



The halibut is an important food fish that lives in northern waters. It has a flat body with both eyes on its right side.

Halibut are caught with strong hooks tied a short distance apart on long lines. The hooks are baited and then dropped to the ocean bottom. They are also caught by trawl nets.

Halibut are enormously fertile. A 90 kilogram female produces over 2 million eggs in one spawning.

Scientific classification. Halibut make up the family Hippoglossidae. The Atlantic halibut is *Hippoglossus hippoglossus.* The Pacific halibut is *H. stenolepis.*

See also **Fish** (picture: Fish of coastal waters and the open sea); **Fishing industry** (Fishery conservation); **Flatfish; Flounder.**

Halifax (pop. 113,577; met. area pop. 295,990) is the capital of Nova Scotia, Canada. Halifax has a large harbour that ranks as Canada's main naval base and busiest east coast port.

British settlers founded Halifax in 1749. Great Britain (now known as the United Kingdom) built a military base there because of its growing struggle with France for control of North America. Halifax is one of Canada's most historic cities. Canada's first representative government was established in Halifax in 1758. Province House, Canada's oldest parliament building, still stands in the city centre.

The economy of Halifax depends heavily on six military bases in the area, and the cargo handled at the port. A commercial centre developed in the 1960's.

See also **Nova Scotia.**

Halifax is a town in the Calderdale local government district of West Yorkshire, England. It is an important clothing manufacturing town. See **Calderdale** and **Yorkshire.**

Halite. See **Salt.**

18.6.2010
14020

Hall, Ben (1837-1865), was an Australian bushranger. Hall was a member of the gang that held up the Forbes gold escort at Eugowra. Soon after, Hall became the gang's leader. He reduced the gang to five and began a three-year reign of terror. He is reported to have committed 10 mail robberies, 20 raids on settlers' homes, and several holdups of towns.

Hall repeatedly inflicted vicious humiliations on the policemen he captured. There is no direct evidence that Hall committed murder himself. But he did take part in the killing of Sergeant Parry on Nov. 16, 1864, and the cold-blooded shooting of Constable Nelson at Collector on Jan. 26, 1865. This shocking crime finally destroyed all romantic stories of Ben Hall's gallantry. A few months later, on May 5, 1865, Hall was shot dead by a former friend, Billy Dargin, at Billabong Creek, near Forbes.

Hall was born at Breeza, in New South Wales.

Hall, Charles Martin. See **Aluminium** (How aluminium is made; History).

Hall, James N. See **Nordhoff and Hall.**

Hall, Sir Peter (1930-   ), an English theatrical director, won fame with his production of contemporary plays, such as *Waiting for Godot* by Samuel Beckett, *The Waltz of the Toreadors* by Jean Anouilh, and *Camino Real* by Tennessee Williams. He later became noted for his exciting productions of Shakespeare's plays. He produced his first professional work at the age of 23. Hall was appointed codirector of the Royal Shakespeare Company in 1968. From 1973 to 1988, he was director of the National Theatre in London. He was born at Bury St. Edmunds, in Suffolk, and was knighted in 1963.

Hall effect is an electrical phenomenon that occurs when a current flows through a material in a magnetic field. For example, if a material has a current flowing through it perpendicular to a magnetic field around the material, the Hall effect is observed as a voltage across the material. The Hall voltage is perpendicular to both the direction of the current and the direction of the magnetic field.

For any given material, the Hall voltage is proportional to the current and the magnetic field. Different materials produce different Hall voltages. Therefore, scientists can use the Hall effect as an experimental tool to describe the electrical properties of materials. For example, the Hall voltage produced in metals is much smaller than that produced in semiconductor materials. The Hall effect was discovered in 1879 by the American physicist Edwin H. Hall.

Hallam, Henry (1777-1859), was an English historian who is best remembered for three main works. The first, published in 1818, was *A View of the State of Europe During the Middle Ages. The Constitutional History of England,* published in 1827, covers the period from 1485 to 1763. It emphasizes the conflict between law and the royal prerogative. The third work was *An Introduction to the Literature of Europe in the 15th, 16th, and 17th Centuries.* Hallam was born at Windsor, in Berkshire.

Hallé, Sir Charles (1819-1895), an internationally admired conductor and pianist, founded the Hallé Orchestra in 1857 and was influential in founding the Royal Manchester College of Music. In 1893, he became the college's first principal. Hallé was born at Hagen, in Germany, and was named Carl Hallé. In 1848, he made his home in England. He was knighted in 1888.

Edmond Halley

Halley, Edmond (1656-1742), also spelled Edmund, was an English astronomer noted for his work on comets. He calculated the orbit of a comet he observed in 1682 and proved that the comet was the same one astronomers had seen in 1531 and in 1607. He predicted its return in 1758. It was seen on Christmas Day of that year and reached its nearest point to the sun in 1759. This comet became known as Halley's Comet. See **Halley's Comet.**

Halley produced the first accurate map of the stars visible from the Southern Hemisphere. He proved that stars have *proper motion*—that is, they change position in relation to each other. Halley studied the orbit of the moon and the effect of the moon on ocean tides. He also determined an accurate way to measure the distance of the sun from the earth. This measurement was needed for determining the size of the solar system and the distances of other stars from the earth.

Halley was born in London. He attended Oxford University and served as England's astronomer royal from 1720 until his death.

See also **Insurance** (History).

Halley's Comet is a brilliant comet named after the English astronomer Edmond Halley. Before Halley made his investigations, most people believed that comets appeared by chance and travelled through space in no set path. However, Halley believed that comets belonged to the solar system and took definite paths around the sun at regular intervals.

Halley found that the paths of certain comets seen in 1531 and 1607 were identical with the path of a comet observed in 1682. He concluded that all the observations were of a single comet travelling in a set orbit around the sun. Halley predicted that the comet would reappear in 1758 and at fairly regular intervals thereafter. The comet was indeed seen in 1758. Halley's Comet appears an average of every 77 years. The first reported sightings were made by Chinese astronomers about 240 B.C.

Halley's Comet can be seen in its orbit only as it nears the sun. In August 1909, scientists at Helwan Observatory in Egypt photographed the comet when it was about 480 million kilometres from the sun. On April 24, 1910, it came as close as 89 million kilometres to the sun. On May 21, 1910, the earth is believed to have passed through the comet's tail. The comet was last observed during that appearance on July 1, 1911.

On Oct. 16, 1982, astronomers at the Palomar Observatory in California, U.S.A., made the next sighting of Halley's Comet. They photographed the comet when it was about 1.6 billion kilometres from the sun. The comet made its closest approach to the sun on Feb. 9, 1986. In March of that year, several unmanned spacecraft drew near the comet, collecting information about its composition and the size of its *nucleus* (centre). The *Giotto,* launched by the European Space Agency, made the closest approach, coming within 544 kilometres of the comet's nucleus.

18.6.2010
14020

In 1991, astronomers observed Halley's Comet surrounded by a huge cloud of dust. Most astronomers believe the cloud was caused by a pocket of frozen gas, such as carbon monoxide, under the comet's crust. The gas vaporized and built up pressure until it burst through the crust, releasing the dust cloud.

The earth passes through the orbit of Halley's Comet each May and October. Pieces of dust left behind by the comet enter the earth's atmosphere and burn, producing meteor showers during these months.

See also **Comet; Halley, Edmond.**

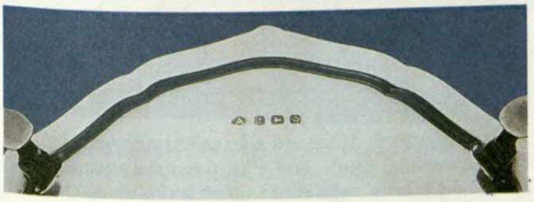
Halliburton, Richard (1900-1939), was an American adventurer, author, and lecturer. He visited many parts of the world and wrote excitedly about his trips. Halliburton's daring got him into dangerous situations that give suspense to his books. His deep knowledge of history helped him relive the lives of leading historical figures in many countries.

Halliburton's writings include *The Glorious Adventure* (1927), *New Worlds to Conquer* (1929), *The Flying Carpet* (1932), *Seven League Boots* (1935), and *Richard Halliburton's Complete Book of Marvels* (1937).

Halliburton was born in Brownsville, Tennessee, U.S.A. He graduated from Princeton University. In 1939, he tried to cross the Pacific Ocean in a specially built Chinese *junk* (sailing vessel). The junk was caught in a storm, and everyone on board was lost.

Hallmark is an official mark used in many countries to stamp gold, silver, or platinum articles in order to guarantee their standard. By law, makers of articles intended for sale must use metal of a fixed standard of purity. Before articles are sold, they must be sent to an assay office for testing. There, officials stamp marks on the articles: the standard mark, the assay office mark, and the date mark. Together, these marks make up the hallmark. In the United Kingdom (UK), new articles that are not up to standard are broken. Gold, silver, and platinum objects that have been imported for sale in the UK or Ireland must also be hallmarked. Items do not have to be hallmarked if they were made before 1900, or if they have already been hallmarked in Austria, Denmark, Finland, Norway, Portugal, Sweden, or Switzerland.

A silver tray, *above,* carries a hallmark. The mark, on the base of the tray, *below,* shows that the tray was stamped in the Birmingham assay office in England, in 1949-1950.



The law of hallmarking applies to most gold, silver, and platinum articles. Hallmarks may be stamped anywhere on an article provided that they can be seen clearly. But officials take care not to spoil the design. The assay offices authorized to do hallmarking in the UK are in Birmingham, Edinburgh, London, and Sheffield. The Irish authorized office is in Dublin.

The standard mark shows that the metal from which the article is made has been tested and found to be of the required purity.

British assay offices mark gold articles according to four standards of fineness: 916·6, 750, 585, and 375. These standards indicate the number of parts of gold in 1,000 parts of metal. Articles are stamped with the figures of their standard of fineness. Before 1975, these standards were expressed as 22-carat, 18-carat, 14-carat, and 9-carat.

The Dublin assay office marks for gold are stamped on objects sideways. The office uses carats as a standard and has a 20-carat standard of gold fineness, in addition to the four standards used in the United Kingdom.

The assay office mark indicates the assay office that has tested and stamped the article. It may also be called the *hallmark.* Makers may send articles to any office. But they usually send them to the most convenient office. On imported goods, Birmingham uses a triangle, Dublin a *bouget* (a mark like a capital *M*), Edinburgh a St. Andrew's cross, London the Zodiac sign Leo, and Sheffield the sign Libra.

The date mark shows the date of stamping. In the UK this mark is also called the *annual letter,* because it is in the form of a letter that changes each year. Under the Hallmarking Act, 1973, the letter changes on January 1. In 1975, assay offices in the UK began using the same letter. The letters usually follow in alphabetical order, and each series is called a *cycle.* Each cycle has its own style of lettering. For example, one cycle may have Roman capitals and the next may have small italic letters.

The sponsor's mark is stamped on an article by the maker, or sponsor, before it is sent to the assay office. From the late 1300's to the 1600's, each maker had his own special mark. It was usually an emblem, such as a crown or a star. But, after 1697, the law required that the mark consist of the first two letters of the goldsmith's surname, such as *CO* for *Coles* or *FA* for *Farren.* Since 1739, the sponsor's mark must consist of the initial letters of both the first name and surname, such as *WB* for *William Bateman.*

History. Hallmarking started in France in the late 1200's. English hallmarking began in 1300, when London goldsmiths stamped their goods with a leopard's head, the mark of their hall or guild. In 1327, their charter gave them power to assay and mark gold and silver articles that met minimum standards of fineness. The maker's mark was first used in England in 1363, and the date mark in 1478. After 1544, a *lion passant* (lion walking with the right paw raised) was used in London as the standard mark on silver. Other English assay offices have used this mark since 1719.

A jack-o'-lantern for Halloween is made by carving a pumpkin. Most jack-o'-lanterns are hollowed-out pumpkins with funny faces cut into them. Candles or other lights are placed inside.

Halloween is a festival that takes place on October 31. In some Western countries, children wear fancy dress on Halloween and go trick-or-treating. Many carve jack-o'-lanterns out of pumpkins.

Halloween developed from ancient new year festivals and festivals of the dead. In the A.D. 800's, the Christian church established All Saints' Day on November 1. The Mass that was said on this day was called *Allhallowmas.* The evening before All Saints' Day became known as *All Hallows' Eve,* or *All Hallow e'en.*

Halloween customs

Trick-or-treating is a Halloween activity for many children. The youngsters dress in costumes and masks and go from door to door saying "trick or treat." The neighbours, to avoid having tricks played on them, give the children such treats as fruit, money, and sweets.

Jack-o'-lanterns are hollowed-out pumpkins with a face cut into one side. Most jack-o'-lanterns contain a candle or some other light. People in England and Ireland once carved out beets, potatoes, and turnips to use as lanterns on Halloween. These lanterns were hung to frighten away witches and evil spirits.

Other Halloween traditions. Bobbing for apples in a tub of water probably began in England. Another version of this Halloween game is snap-apple. The players try to take bites out of an apple hanging from a length of string. These games began as ceremonies to "honour the fruit" at the end of the harvest season.

People once believed that ghosts roamed the earth on Halloween. They also thought that all witches met on October 31 to worship the devil. Today, most people do not believe in ghosts, but these supernatural beings remain symbols of Halloween.

History

The Celtic festival of Samhain is probably the origin of the present-day Halloween celebration. The Celts lived more than 2,000 years ago in what is now the United Kingdom, Ireland, and northern France. Their new year began on November 1. A festival that began the previous evening honoured Samhain, the Celtic lord of death. The celebration marked the beginning of the season of cold, darkness, and decay. On the evening of the festival, the Druids, who were the priests and teachers of the Celts, ordered the people to put out their hearth fires. The Druids built a huge new year's bonfire and burned animals, crops, and possibly even human beings as sacrifices. Then each family relit its hearth fire from the new year's fire. They told fortunes about the coming year by examining the remains of the animals that had been sacrificed.

The Romans conquered the Celts in A.D. 43 and ruled what are now England and Wales for about 400 years. During this period, two Roman autumn festivals were combined with the Celtic festival of Samhain. One of them, called *Feralia,* was held in late October to honour the dead. The other festival honoured Pomona, the Roman goddess of fruit and trees. It seems likely that apples first became associated with Halloween because of this festival.

All Saints' Day. Many of the customs of the Celts survived even after the people became Christians. During the 800's, the church established All Saints' Day on November 1 (see **All Saints' Day**). The people made the old pagan customs part of this Christian holy day. The church later began to honour the dead on November 2. This day became known as All Souls' Day.

Regional Halloween customs developed among various groups of Celts. In Ireland, for example, people begged for food in a parade that honoured Muck Olla, a god. In Wales, every person marked a stone and put it into a bonfire. The people believed that if a person's stone was missing the next morning, he or she would die within a year.

In England, Halloween was sometimes called *Nutcrack Night,* or *Crab Apple Night,* or *Apple and Candle Night.* Families sat by the fire and told stories while they ate apples and nuts. On All Souls' Day, poor people went *a-souling* (begging). They received pastries called *soulcakes* in exchange for promising to say prayers for the dead. In England, some Halloween customs became mixed up with Guy Fawkes Night, on November 5, which is also celebrated by lighting bonfires.

Hallucination is a mental state in which a person sees, hears, tastes, smells, or feels something that is not present. Hallucinations may indicate the presence of a mental or physical disorder. However, normal people also may hear voices or see visions when deprived of stimuli, such as in solitary confinement or when under the influence of certain drugs. See also **Mental illness** (Schizophrenia).

Hallucinogen is any of several substances that distort a person's understanding of himself and his surroundings. These drugs temporarily change the chemistry of the brain. They affect the senses, emotions, reasoning, and the brain's control of muscles and certain body functions. The changes may be extremely pleasant or highly unpleasant and frightening. Many countries have enacted laws restricting the manufacture, distribution, and possession of these drugs.

Hallucinogenic drugs are also called *psychedelic* (mind revealing) drugs. The most powerful such drug is *LSD* (see **LSD**).

The effects of hallucinogenic drugs are sometimes called *trips.* During a trip, a drug user may see bright, moving colours. The size, arrangement, and shape of objects may appear to change constantly. The user may *hallucinate* (see or hear things that are not present). The person may step out of a window, not realizing the danger of being hurt or even killed. Drug users may vividly recall past experiences. They may have a sense of overwhelming fear, sadness, and horror, or feel intense love and joy. During a trip, drug users may feel that they have gained a new understanding of God, the universe, and themselves.

The effects of hallucinogenic drugs last from one hour to several days. But these effects may appear again months later as a *flashback.* People may feel unusually happy or upset for weeks after using hallucinogenic drugs. Some users become mentally ill. A trip and its effects vary from person to person and from trip to trip. The experience and its effects are influenced by three main factors. These are (1) the type and amount of drug taken, (2) the circumstances in which the drug is used, and (3) the user's personality and mood. Hallucinogenic drugs are not addictive. Some scientists believe that use of hallucinogenic drugs by pregnant women may cause birth defects.

Hallucinogenic drugs may someday prove useful to science. Scientists have used them to study the chemistry of the brain. Doctors have used the drugs experimentally to treat certain types of mental illness.

See also **Drug abuse.**

Halo is a luminous ring or a disc of light that surrounds an object. Halos commonly appear in Christian religious art as a symbol of saintliness or divinity. In many religious paintings created since the 400's, Jesus Christ and the Virgin Mary, as well as the angels and saints, have been portrayed with a shining circle around the head. The golden or jewelled crowns worn by royalty were originally modelled after the sacred halo. Such a crown was meant to signify the wearer's "divine right" to rule.

The term *halo* is also used in connection with various natural phenomena. The pale ring of light that occasionally appears around the sun or moon is called a halo. Such rings are most often seen during winter. They appear when light rays are *refracted* (bent) by ice crystals in the earth's upper atmosphere.

Another type of halo is the luminous ring of stars that surrounds a spiral or elliptical galaxy (see **Galaxy**). This *galactic halo* consists of older stars containing few elements heavier than hydrogen and helium. It may extend hundreds of thousands of light-years from the centre of a galaxy.

Astronomers also speak of a halo of comets surrounding the solar system. These comets all orbit the sun at a distance of about 100,000 *astronomical* units (see **Astronomy** [Astronomy terms]). Many of the comets themselves are enveloped by a halo composed of hydrogen gas. This halo forms when a comet travels close enough to the sun for the frozen methane and ammonia in the comet's head to change directly into gas.

A lunar halo appears as a ring of light around the moon. It is seen when light rays reflected from the moon are bent as they pass through ice crystals in the earth's upper atmosphere.

Halogen. The halogens are the chemical elements astatine (chemical symbol, At), fluorine (F), chlorine (Cl), bromine (Br), and iodine (I). They are nonmetals, and make up part of the seventh main group in the periodic system of the elements. *Halogen* means *salt producer.* Many of the salts in the sea are compounds of halogens with metals. Common table salt, the best known such compound, is sodium chloride (NaCl).

The halogens all have a strong, unpleasant odour, and will irritate the skin. They do not dissolve well in water. At ordinary temperatures, fluorine is a pale yellow gas, chlorine a yellowish-green gas, bromine a red liquid, and iodine a black solid. Fluorine is the lightest halogen; astatine is the heaviest. The atomic weight of fluorine is 18.9984; of chlorine, 35.453; of bromine, 79.909; of iodine, 126.9044; and of astatine, 210.

The five elements of the halogen group are electronegative. This means that the atoms of halogens tend to *oxidize* (take up electrons from) other chemicals and become charged with negative electricity. They are then called *negative ions.* The salts, called the *halides,* are compounds formed by these ions. All the halogens are oxidizing agents. However, the heavier the atomic weight of the halogen, the weaker its oxidizing power. Fluorine is the strongest of all oxidizing agents. It is also extremely reactive.

The halogens react with most metals and many nonmetals. Their reactions with hydrogen give the hydrogen halides. The most important of these is hydrogen chloride, (HCl), which dissolves in water to make hydrochloric acid.

The halogens and their compounds have many uses. Fluorides are used to make aluminium, steel, and the nonstick plastic Teflon. Small quantities of fluorides are added to some toothpastes and drinking water to help prevent tooth decay. Chlorine and its compounds are important in making paper and plastics, and in purifying drinking water. Bromine is used to make dyes, fire-retardant chemicals, and medicines. The iodine compound silver iodide (AgI) is used in photographic film. Other iodine compounds are valuable antiseptics and disinfectants. Astatine also has important uses in medicine.

See also **Astatine; Bromine; Chlorine; Fluorine; Iodine.**

Halothane is a *general anaesthetic*—that is, it produces unconsciousness and loss of feeling throughout the entire body.

Halothane is a clear, colourless liquid that gives off pleasant-smelling, non-irritant vapours. Halothane vapour is nonflammable. Halothane therefore poses no risk of fire or explosion when used in the presence of electrical equipment. Patients who have received halothane regain consciousness rapidly.

Halothane is usually administered along with other drugs. Doctors often induce anaesthesia with an injection of thiopentone sodium, a barbiturate. Halothane is then administered to maintain anaesthesia during surgery. Patients inhale the halothane vapour, usually in combination either with oxygen or with a mixture of oxygen and nitrous oxide. In many cases, drugs that provide additional muscle relaxation are also administered to the patient.

Halothane was discovered in England in 1951 and was first used in surgery in 1956 in the United States. Since then, halothane has become extremely popular. It has replaced ether as the standard by which other inhaled anaesthetics are judged. Halothane's chemical formula is $F_3C\text{-}CHBrCl$. Its trade name is *Fluothane.*

The discovery of halothane led to the search for other safe and effective anaesthetics that contain halogens (see **Halogen**). Of the hundreds of such compounds that have been found and studied, only two—enflurane and isoflurane—have emerged as useful agents for producing anaesthesia.

See also **Ether; Nitrous oxide.**

Oil painting on canvas (1623); The Metropolitan Museum of Art, New York City

Frans Hals's *Yonker Ramp and His Sweetheart* shows the smiling, healthy people who made the Dutch painter famous. Hals was known for his ability to portray lively expressions.

Hals, Frans (1580?-1666), was one of the finest Dutch portrait painters of the 1600's. His portraits are known for showing lively expressions and poses. In his group portraits, the expressions and poses are coordinated to maintain the balance of the composition. He painted with bold, broad brushstrokes.

Hals used several kinds of subjects for his portraits, including individuals and married couples. He painted group portraits of *civic guards* (social organizations for men) and leaders of social welfare organizations. One of these paintings, *Banquet of Officers of the Civic Guard of Saint George at Haarlem, 1616,* appears in the **Painting** article. Before 1640, along with formal portraits, Hals often painted half-lengths of children and the colourful types of people he may have met at inns. These paintings are thought to have symbolic or allegorical meanings.

Hals was born in Antwerp, Belgium. He spent most of his life in Haarlem, the Netherlands, where his parents moved to escape Spanish rule. See also **Descartes, René** (picture).

Halsey, William Frederick, Jr. (1882-1959), was one of the leading United States naval commanders in World War II. General Douglas MacArthur called him "the greatest fighting admiral" of the war.

Halsey became vice-admiral in command of a Pacific carrier division in 1940. He commanded this division in attacks on the Gilbert and Marshall islands and on Wake Island and Marcus Island in February 1942. Later in 1942, he took command of U.S. naval forces in the South Pacific. In a series of bloody battles, his forces defeated the Japanese in the Solomon Islands. This victory enabled American land forces to occupy the entire island chain.

During this period, Halsey also supported the opening offensives of General MacArthur in the Southwest Pacific. Halsey took command of the Third Fleet on June 15, 1944. In the Battle of Leyte Gulf in October 1944, Halsey's fleet and Admiral Thomas Kincaid's Seventh Fleet smashed the Japanese Navy and virtually eliminated it from the war.

The Japanese later signed the surrender on Halsey's flagship, the battleship *Missouri.* Halsey was born in Elizabeth, New Jersey, and graduated from the U.S. Naval Academy in 1904.

See also **World War** II (The South Pacific; The liberation of the Philippines).

Halton (pop. 121,400) is a local government district in Cheshire. It includes the industrial towns of Runcorn and Widnes. Production of chemicals, biscuits and potato crisps, animal foods, and clothing are the main industries. Runcorn, an ancient community, was designated a new town in 1964. Widnes has a strong rugby league team.

Ham, son of Noah. See **Noah.**

Ham is the meat taken from the hind leg of a pig. Ham is an important food product. It is an excellent source of protein. It is also high in thiamine, iron, and other vitamins and minerals.

People serve ham in a wide variety of ways, including as a main dish, mixed into salads, on sandwiches, and in spreads. The ways to prepare ham include grilling, roasting, and frying. Some ham comes pre-cooked and can be sliced and eaten without reheating.

Kinds of ham. Ham is sold as a whole leg or cut into smaller portions. The chief types of cuts are called *gammon steaks* and *joints, bacon chops,* or *longback, middle back, prime back* and *streaky bacon,* or *prime collar* and *forehock.* The names refer to the part of the leg from which a cut is taken.

Ham is sold also in unprocessed and processed forms. The processed form is the kind most commonly referred to as ham. Fresh ham is an unprocessed, lean meat that has a delicious flavour when cooked. It spoils quickly and must be cooked or stored in a freezer soon after purchase.

Ham producers process ham by curing and smoking it. Ham prepared using either or both of these methods may be stored for several weeks or months without spoiling. Cured and smoked ham generally has a salty or sweet flavour and a smoky aroma.

Curing and smoking. Ham is cured using such ingredients as salt, sodium ascorbate, sodium nitrite, sodium phosphate, and sugar. Producers usually dissolve these ingredients in water to form a *curing brine.* They pump some of the brine into the ham. They then soak the ham in the remaining brine for three to seven days. Ham cured in this manner includes canned ham and luncheon meat. Producers cure some types of ham by rubbing them on the outside with dry curing ingredients. Such ham includes dry-cured ham, country ham, and country-style ham. These kinds of ham do not require refrigeration for storage, but must be soaked in water before they can be cooked and eaten.

Most cured ham is also smoked. Producers begin the smoking process by placing the ham in a large, walk-in oven called a *smokehouse* for cooking. They then create smoke by burning sawdust in a separate stove called a *smoke generator.* While the ham is cooking, fans blow the smoke from the smoke generator into the smokehouse. The smoke adds flavour to the ham. It also turns the ham a golden brown on the outside. Cooking causes chemical reactions to take place in the curing ingredients. These reactions make the meat turn pink.

See also **Meat; Meat processing; Pork.**

Ham. See **Radio, Amateur.**

Hamadryas. See **Baboon.**

Haman, in the Old Testament, is the villain of the book of Esther. A favourite of the Persian king, Ahasuerus, he won a high rank. Everyone bowed to him. However, Mordecai, who was a Jew, refused to bow. Haman became enraged and plotted to have all the Jews in the empire killed.

Queen Esther, a Jew, was Mordecai's cousin. The king did not know that she was Jewish. Risking her life, Esther told the king she was a Jew and pleaded for her people. Esther succeeded, and Haman was hanged instead of Mordecai. See also **Esther, Book of.**

Hambleton (pop. 77,600) is a local government district in North Yorkshire, England. Important local industries include engineering, farming, food processing, and production of animal feed. Northallerton is the administrative centre of the district and of the county of North Yorkshire. Thirsk has a course for horse racing. See also **Yorkshire.**

Hamburg (pop. 1,579,884) is Germany's second largest city and its most important industrial centre. It is one of the largest seaports in Europe.

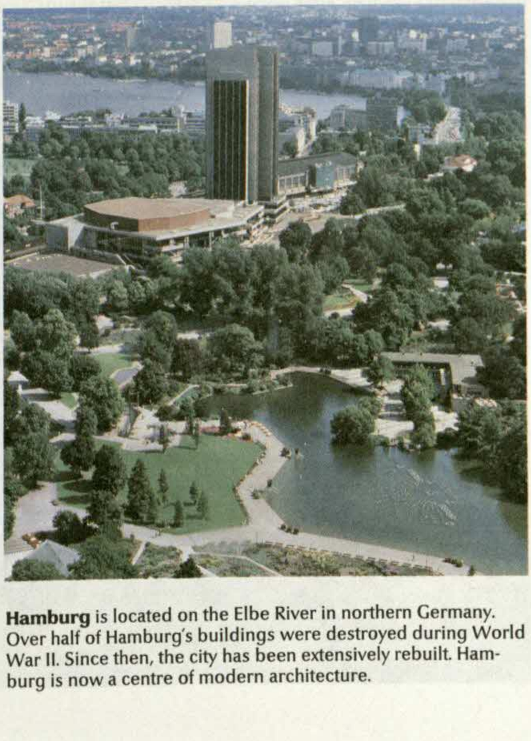
Hamburg lies on the Elbe River, about 110 kilometres from the river's mouth on the North Sea (see **Germany** [political map]). The Alster River flows through Hamburg and forms two large lakes in the city. These lakes are called the Binnen-alster and the Aussen-alster. Many narrow canals crisscross the city.

The city today. Hamburg was one of the most heavily bombed German cities during World War II. Incendiary bombs caused huge fires. Large parts of the city's port and commercial areas were wiped out and many old churches and homes were badly damaged or destroyed. But the port and commercial areas have been rebuilt since the war. The *Rathaus* (town hall), the new opera house, and many modern buildings give Hamburg an attractive appearance. The Hagenbeck zoo, the University of Hamburg (founded in 1919), and many museums are located there. The city is a centre of German political and cultural activities.

Hamburg's industries include chemical plants, iron and steel works, and saw mills. They process many raw materials such as farm products, ores and metals, wood, and wood pulp. Shipbuilding has been an important industry for many years. The city's food industry processes cereals, coffee, fish, meat, and tobacco.

The harbour, stretching along the Elbe, is the hub of Hamburg's economic life. It is a centre for foreign and inland shipping. Many of Germany's industrial products, including cars, machinery, and optical goods, are exported from Hamburg. Imports include such products as coffee, fruit, paper, and tobacco.

Hamburg is also one of Germany's leading railway centres. There is heavy rail traffic between the city and every part of Europe. National publications are published in Hamburg. They include the news magazine *Der Spiegel* and the newspapers *Die Zeit* and *Die Welt.*



Hamburg is located on the Elbe River in northern Germany. Over half of Hamburg's buildings were destroyed during World War II. Since then, the city has been extensively rebuilt. Hamburg is now a centre of modern architecture.

In the 1200's, Hamburg was a leading member of the Hanseatic League, a confederation of North German cities. In the late 1800's and early 1900's, it was a state in the German Empire and the Weimar Republic.

Hamburg State is a *land* (state) in northern Germany and is represented in the parliament in Bonn. Hamburg State has its own constitution, passed in 1952. It has a *Bürgerschaft* (parliament). The people elect the 120 Bürgerschaft members to four-year terms. Bürgerschaft members choose a 15-member senate to administer the laws. The *first bürgermeister* (chief official) heads the senate. Hamburg is divided into seven administrative districts.

Hamengku Buwono IX (1912-1988) was sultan of Yogyakarta, Java, from 1939 to 1988. In 1945, he joined Indonesian nationalist leaders in their struggle against Dutch rule. After Indonesian independence was recognized in 1949, he became one of the country's most respected and influential leaders.

He was born in Yogyakarta, the son of Sultan Hamengku Buwono VIII, ruler of Yogyakarta under the Dutch. His father named him Dorojatun. He was educated by Dutch teachers. He attended the University of Leiden in the Netherlands. When Dorojatun was installed as sultan in 1940, he took the name Hamengku Buwono IX.

After the surrender of the Japanese in August 1945 and the proclamation of Indonesian independence, he sent a telegram supporting the Indonesian nationalist leaders. Hamengku Buwono IX served as a minister in several cabinets under President Sukarno between 1946 and 1953, and under President Suharto from 1966. He served as Indonesia's second vice-president from 1973 until 1978.

Hamersley Range, in the northwestern part of Western Australia, is one of the richest mineral areas in the world. It contains large deposits of asbestos, copper, iron, manganese, and tin. See also **Mount Newman, Mount Tom Price,** and **Western Australia.**

Hamilcar Barca (? -229 B.C.) was a great general of Carthage and the father of Hannibal, Carthage's most famous general. In 247 B.C., during the First Punic War, Hamilcar took command of the Carthaginian forces in western Sicily. His forces fought the Romans valiantly, but the Carthaginians suffered a disastrous naval defeat. Carthage was forced to sue for peace in 241 B.C. After the war, Hamilcar put down a rebellion in Africa of *mercenaries* (hired troops) who had not been paid. He moved against other rebellious mercenaries on the island of Sardinia, but Rome demanded and got Sardinia and money from Carthage.

Hamilcar governed Carthage's holdings in Spain from about 237 B.C. until his death. He expanded Carthaginian power and territory. His work helped bring the economic strength that Carthage and Hannibal needed to fight the Second Punic War.

See also **Carthage; Hannibal; Barcelona.**

Hamilton (pop. 9,756) is a city in Victoria, Australia. It lies on the banks of a stream called the *Grange Burn*. The surrounding district carries huge numbers of sheep and cattle. Cereal and oilseed crops are also widely grown. Hamilton has a wool-scouring plant, large modern abattoirs, and light manufacturing and service industries. Tourist attractions include an art gallery, botanic gardens, and an artificial lake.

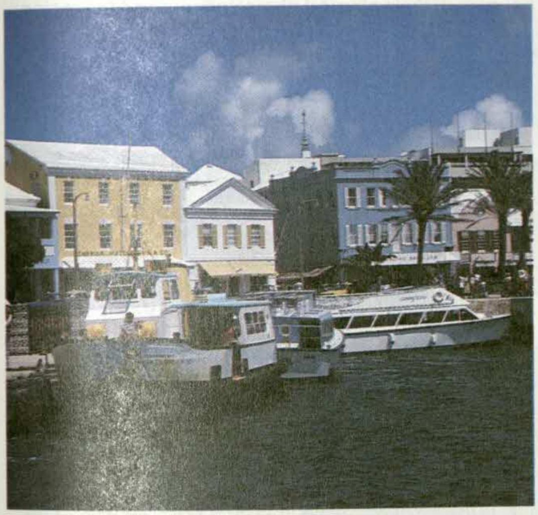
The Grange Burn was named by the explorer Sir Thomas Mitchell in 1836, and Hamilton was originally known as *The Grange*. It was created a borough in 1863. Hamilton became a municipal city in 1949.

Hamilton (pop. 1,669) is the capital and chief port of Bermuda. It lies along the central coast of Bermuda Island. For location, see **Bermuda** (map).

Hamilton has many buildings that are painted in pastel colours. Few buildings are over three storeys high.

Bermuda is a popular resort, and tourism is a major source of Hamilton's income. Large cruise ships dock in the city's harbour along Front Street, the main street. Many shops are located along Front Street. Other attrac-

Hamersley Range, in Western Australia, contains one-tenth of the world's known resources of iron ore, as well as other minerals.



Hamilton, Bermuda, is a popular tourist resort. Ships can dock alongside Front Street, the city's main street.

tions include Albouy's Point, site of the Royal Bermuda Yacht Club; a park called Par-La-Ville Gardens; and the Bermuda Historical Society, which displays items from Bermuda's past.

Hamilton was founded in 1790. In 1815, it replaced St. George as the capital.

Hamilton, Ontario, is in Canada. It is the centre of the Canadian steel industry. Plants in the Hamilton area produce about half the nation's steel. Hamilton's location on Hamilton Harbour on the west end of Lake Ontario makes the city an important link in the St. Lawrence Seaway route.

Almost 70 per cent of Hamilton's people were born in Canada. About 60 per cent of the people have British ancestors. Italians make up about 8 per cent of the population. Hamilton also has large German and Polish communities.

Hamilton (pop. 148,625) is a city in the North Island of New Zealand. The city is built on both sides of the Waikato River. Five road bridges and a rail bridge cross the river.

The centre of the rich Waikato farming district, Hamilton is the most important inland distributing point for primary products in New Zealand. In 1970, the largest railway marshalling yards in New Zealand began operating at Te Rapa. They cover 32 hectares. Lake Rotorua provides facilities for yachts and the Waikato River is used for water sports. Agricultural shows are held at Claudelands.

Victoria Street is the city's main business centre. Hamilton has two cathedrals, a public library, theatres, an art museum and several private art galleries, and the large Waikato Hospital. The University of Waikato and Hamilton Teachers' College share a 50-hectare campus in the city. Waikato Technical Institute is in the central city.

Hamilton was named in honour of John Hamilton, a British naval officer. He was among those killed in the battle against the Maoris at Gate Pa, near Tauranga.

Hamilton (pop. 103,139) is a local government district in Strathclyde Region, Scotland. Fruit-growing is the most important agricultural activity. Industries include textile and chemical production and light engineering. The chief towns are Hamilton, Blantyre, and Larkhall.

Hamilton, Alexander (1755 or 1757-1804), was a noted statesman and political leader during the early years of the United States.

Hamilton was born on the island of Nevis in the West Indies. As a boy, he worked for a trading firm. His talents so impressed his employers that they helped send him to school in North America. He attended a school in Elizabethtown (now Elizabeth), New Jersey, and then entered King's College (now Columbia University).

In 1776, during the American Revolution, Hamilton was appointed captain of a New York artillery company. From 1777 to 1781, he served as a secretary and close assistant of General George Washington. Hamilton was admitted to the bar in New York in 1782 and soon began to practise law there. Also in 1782, he became a dele-

Waikato River flows through the city of Hamilton in the North Island of New Zealand.

Hamilton, the largest city of the Waikato region, has Garden Place as its main centre.

gate from New York to the Congress of the Confederation. Hamilton became secretary of the treasury in 1789. He recommended measures to encourage manufacturing, and Congress partly followed Hamilton's suggestions. In the early 1790's conflicts between Hamilton and his opponents resulted in the development of the nation's first two political parties. Hamilton led the Federalist Party, which favoured a strong federal government. The Democratic-Republican Party, headed by Thomas Jefferson and James Madison, wanted a weak national government.

In 1795, Hamilton resigned as treasury secretary because of personal financial problems and increased opposition in Congress. But he remained active in public life. On July 11, 1804, Hamilton was shot in a dual by political opponent Aaron Burr and died the next day.

Hamilton, Sir William. See **Jet boat.**

Hamilton Island is located off the coast of northern Queensland, Australia, in the Cumberland group of islands in the Great Barrier Reef. It is 270 kilometres south of Townsville and 80 kilometres north of Mackay.

The island has been developed as a tourist resort. It has a 200-berth floating marina and an 80-hectare wildlife park. The resort has a sports club, six pools, seven restaurants, a number of shops, and a convention centre. Its airstrip can accommodate jet aircraft.

The name *Hamilton Island* first appeared on charts in 1866 following a survey of the area by the British Commander George Nares, captain of H.M.S *Salamander.* The island remained uninhabited until 1930, when a doctor named John McDonald secured a grazing lease. He remained on the island until 1951, when Percy Moody took over the lease. In 1975, Keith Williams, a Queensland businessman, bought the lease to set up a commercial deer farm. In 1979, the Queensland Government gave approval for the island to be developed as a tourist resort. Its airstrip opened in 1984.

Hamilton-Gordon, John Campbell. See **Aberdeen and Temair, Marquess of.**

Hamites are certain African peoples who live mainly in eastern, northern, and northeastern Africa, including parts of Ethiopia, the Sahara, and the Sudan. Most Hamites are tall and have a narrow nose and brown skin. They are sometimes called *Afro-Mediterranean* peoples because of their physical characteristics and the region where they live. Because much of this region cannot be farmed, most Hamites tend herds of camels, cattle, goats, and sheep.

The ancient Egyptians were Hamites. Present-day Hamitic peoples include the Beja, Berbers, Fulani, Oromo, and Somali. The languages of Hamites have been called *Hamitic,* but this term correctly refers only to race. The languages used by the Hamites belong to the Cushitic group of Afro-Asiatic languages.

See also **Berbers; Fulani; Khoikhoin; Somalia.**

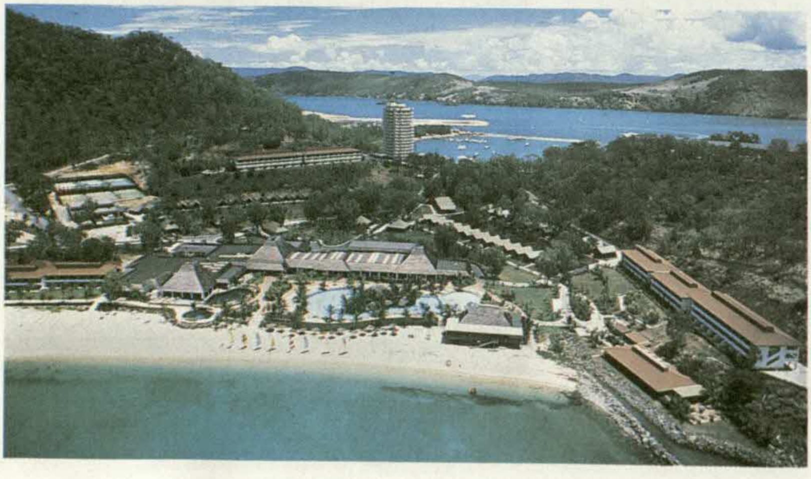
Hamka (1908-1981) is the name by which one of Indonesia's religious leaders and writers on Islamic subjects is known. Hamka is short for Haji Abdul Malik Karim Amrullah.

Hamka was born in West Sumatra. His father was a well-known Islamic scholar. He was taught by his stern father and by other teachers. He also educated himself, especially in the field of Islam. When Hamka was about 16 years of age, he was sent to Java to study under various private teachers. He knew little or no Dutch or English, and his abilities and tastes were developed mainly under the influence of modern Arabic literature. In 1927, he went on a pilgrimage to Mecca, in Saudi Arabia. In 1958, Hamka was given an honorary doctorate by the Al-Azhar University in Cairo, in Egypt. He was chief prayer leader in Indonesia's national mosque. During the time Sukarno was president of Indonesia, Hamka was imprisoned for almost ten years, for preaching that Islam was in danger from the Communists. While in prison, he worked on a lengthy commentary on the *Quran,* the Muslim holy book. As well as his hundreds of books on Islam, he wrote poetry and a number of novels.

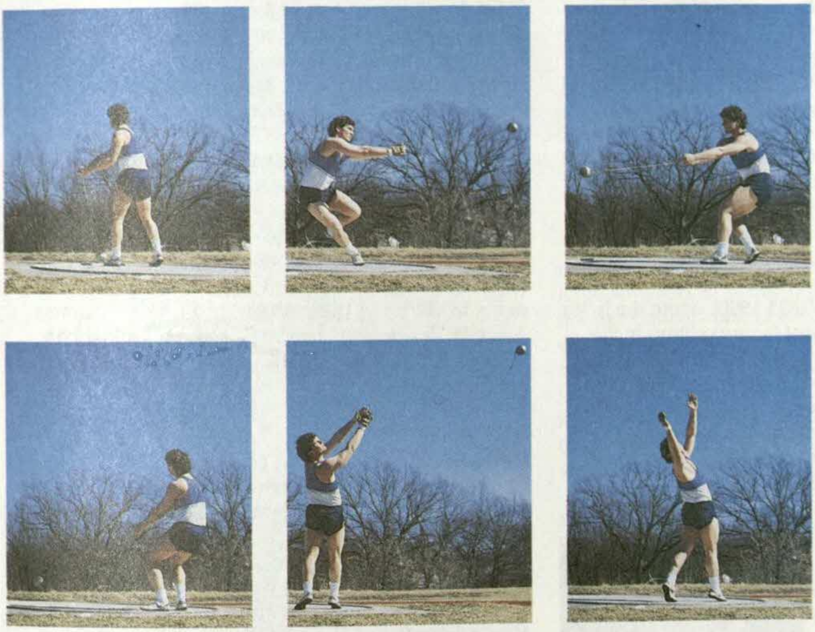
Hamlet. See **Shakespeare, William** (The third period. Hamlet).

Hammarskjöld, Dag (1905-1961), served as secretary-general of the United Nations from 1953 until his death in a plane crash in Africa. After his death, Hammarskjöld was awarded the 1961 Nobel Peace Prize for his efforts to bring peace to the Congo, now Zaire.

Hammarskjöld worked to ease tension between the United States and the Soviet Union. In 1955, he secured the release from China of American prisoners captured during the Korean War. In 1956, he helped solve the



Hamilton Island in the Great Barrier Reef is one of Australia's leading tourist resorts.



The hammer throw requires strength and skill. The thrower whirls around in a circle, swinging the hammer in a lopsided plane. When he gains sufficient momentum, he lets the hammer fly.

Suez crisis between Egypt and Israel and Israel's allies, France and Great Britain.

Markings, a book of poetry, prayers, and prose sayings written by Hammarskjöld, was published in 1964.

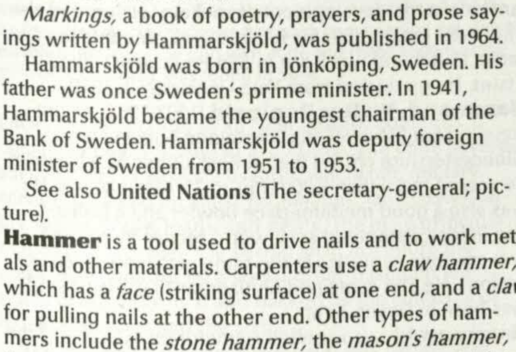
Hammarskjöld was born in Jönköping, Sweden. His father was once Sweden's prime minister. In 1941, Hammarskjöld became the youngest chairman of the Bank of Sweden. Hammarskjöld was deputy foreign minister of Sweden from 1951 to 1953.

See also **United Nations** (The secretary-general; picture).

Hammer is a tool used to drive nails and to work metals and other materials. Carpenters use a *claw hammer,* which has a *face* (striking surface) at one end, and a *claw* for pulling nails at the other end. Other types of hammers include the *stone hammer,* the *mason's hammer,* the *tack hammer,* and the *machinist's hammer,* which is also called the *ball peen hammer.*

Types of hammers

Hammers are made in many different shapes and sizes to do a variety of jobs. A comfortable grip on the handle and good balance are important factors in choosing a hammer.



Hammer throw is a sports contest in which an athlete throws a *hammer* (metal ball) as far as he can. The hammer weighs 16 pounds (7.257 kilograms). The thrower holds it with a metal grip that is connected to the ball by a steel wire up to 4 feet (1.2 metres) long. He throws the hammer from a circle which is 7 feet (2.1 metres) in diameter.

At the beginning of his throw, the athlete faces the back of the circle and places his feet wide apart. He grips the metal handle with both hands, then swings the hammer around his head. When the hammer has gained enough momentum, the thrower takes three or four spins across the circle. The thrower spins on his left foot to increase the speed of the hammer. At the end of the last spin, he has developed great momentum in the whirling hammer, which he then releases. The length of the throw is measured from the edge of the circle to the nearest mark made by the hammer.

For hammer throw championship figures, see **Athletics** (table: World athletics records); **Olympic Games** (table: Athletics).

Hammerhead is the name of sharks with broad-flattened heads. The eyes and nostrils are set wide apart at the extreme edges of the head. The great hammerhead grows to over 6 metres and lives in tropical waters. It is found mainly inshore. The smooth hammerhead grows to 4.5 metres. It is also mainly found in tropical seas but enters cooler waters during the summer months. It feeds mainly on fish including rays, but also scavenges on dead animals and refuse near the coasts. Both species of shark are dangerous.

Scientific classification. Hammerhead sharks belong to the family Sprynidae, genus *Sphryna.* The great hammerhead is *S. mokarran,* the smooth hammerhead is *S. zygaena.*

Hammersmith and Fulham (pop. 136,500) is a borough within the Greater London area. It includes the former boroughs of Fulham and Hammersmith. It lies on the north side of the River Thames, in west London.

Hammersmith Bridge spans the river and joins Hammersmith to Barnes.

Most of Hammersmith and Fulham's working population are employed in distributive trades and office work. The BBC Television Centre, and Lime Grove studios, West London and Charing Cross hospitals, and Wormwood Scrubs Prison all are within the borough. The Lyric Theatre, Riverside Studios, Hammersmith Odeon, and Hammersmith Palais are famous centres of entertainment. Queen's Park Rangers, Chelsea and Fulham association football teams all use grounds within the borough of Hammersmith and Fulham.

Hammerstein, Oscar, II (1895-1960), wrote the lyrics and scripts for many of the most famous shows in the history of American musical theatre. He worked with such great composers of musical comedies as Jerome Kern and Richard Rodgers. Hammerstein maintained an optimistic attitude that was reflected in his songs. These included "Oh, What a Beautiful Mornin' "; "You'll Never Walk Alone"; and "My Favorite Things."

Hammerstein helped revolutionize musical comedies. When he began his career, most musicals consisted of a series of unrelated songs and dances that were held together by a weak plot. Hammerstein integrated the dialogue, songs, and dances into a unified work.

Oscar Hammerstein

Oscar Greeley Clendenning Hammerstein was born in New York City and graduated from Columbia University. He wrote his first musical, *Always You* (1920), with the composer Herbert Stothart. He worked with Stothart and Rudolph Friml on *Rose-Marie* (1924). His other early musicals included *The Desert Song* (1926) and *The New Moon* (1928), which he wrote with Sigmund Romberg. Hammerstein wrote his first masterpiece, *Show Boat* (1927), with Kern.

Hammerstein and Rodgers teamed up for the first time in *Oklahoma!* (1943), which won a Pulitzer Prize in 1944. They wrote eight other musicals—*Carousel* (1945), *Allegro* (1947), *South Pacific* (1949), *The King and I* (1951), *Me and Juliet* (1953), *Pipe Dream* (1955), *Flower Drum Song* (1958), and *The Sound of Music* (1959). In 1950, the two men shared a Pulitzer Prize for *South Pacific* with Joshua Logan, who helped write the dialogue for that musical.

See also **Kern, Jerome; Rodgers, Richard.**

Hammett, Dashiell (1894-1961), was an American novelist regarded by some as the leader of the "hard-boiled" school of detective fiction. His stories feature "tough guys," realism, brutality, and violence. Many of his novels centre on a *private eye* (private investigator). In *Red Harvest* (1929) and *The Dain Curse* (1929), Hammett introduced the "Op" (operative), an agent for the Continental Detective Agency. Sam Spade appears in *The Maltese Falcon* (1930) and Ned Beaumont in *The Glass Key* (1931). Hammett created the witty amateur detectives Nick and Nora Charles in *The Thin Man* (1934). Several of Hammett's short stories were collected in *The Big Knockover* (1966) and *The Continental Op* (1974).

Samuel Dashiell Hammett was born in St. Mary's County, Maryland, United States. Many of his stories reflect his personal experiences as a private detective for the Pinkerton Agency. In 1922, Hammett began writing for *Black Mask,* a magazine that specialized in publishing "hard-boiled" detective stories.

Hammond, Dame Joan (1912-), a New Zealand-born soprano, became famous as an opera singer and concert artist. She studied singing in Europe, making her concert debut in London in 1938 and her operatic debut in Vienna in 1939. In 1946 and 1949, she toured Australia as a concert artist. She retired in 1964. Joan Hammond was born at Christchurch. She spent her early years in Australia, where she was a championship golfer. During World War II, she served as an ambulance driver.

Hammond, John Hays, Jr. (1888-1965), was an American inventor. He obtained hundreds of patents for his developments in radar, radio, television, and other electronic devices.

Hammond pioneered the development of remote control. His devices for the remote control of ships, aeroplanes, and torpedoes aided the U. S. Army and Navy during World Wars I and II. Hammond also invented electronic circuits that stabilized and guided remote control vehicles. These circuits played an important role in the development of rocketry. Hammond also improved tuning systems for frequency modulation (FM) radio. Hammond was born in San Francisco, United States. He graduated from Yale University in 1910.

Hammond, Walter Reginald (1903-1965), an outstanding English cricketer, captained England and Gloucestershire cricket teams. Best known as a batsman, he scored more than 6,000 runs in 79 Test matches. He was also a good medium-pace bowler and a brilliant slip fielder. Hammond set a world record by scoring two separate centuries in the same match on seven occasions. He first captained England in 1938. Hammond was born in Dover, Kent.

Hammurabi, also spelled *Hammurapi,* was one of the greatest kings of Babylon. He developed the famous *Code of Hammurabi,* one of the first law codes in history. He strengthened and expanded his kingdom by diplomacy and military conquest.

Hammurabi was an efficient king who carefully planned every move, often years in advance. He was an outstanding administrator. His reign is known as *the golden age of Babylon.* Hammurabi ruled Babylon for 43 years, from 1792 to 1750 B.C.

Hammurabi changed the legal system of the country by revising older legal codes, including one 300 years old. He compiled the great new code that bears his name. He also set up maximum prices and minimum wages, and gave his kingdom a fair, flexible, and efficient system of taxation. Hammurabi found time even for delicate language reforms. His handling of the Akkadian language, in which the Code of Hammurabi was composed, became a model for all of the future writers of ancient Mesopotamia.

The Code of Hammurabi was based on older collections of Sumerian and Akkadian laws, which Hammurabi revised, adjusted, and expanded. The code greatly influ-

The Louvre, Paris

Hammurabi, King of Babylon, stands before the sun god Shamash, patron of justice. This relief is at the top of the text of the Code of Hammurabi. It shows Shamash commanding the king to establish just laws. The slab with code and relief, known as the stele of Hammurabi, was found in Susa.

enced the civilization of all Near Eastern countries. It contained nearly 300 legal provisions. The code covered such matters as false accusation, witchcraft, military service, land and business regulations, family laws, tariffs, wages, trade, loans, and debts. The main principle of the code was that "the strong shall not injure the weak." The code set up a social order based on the rights of the individual and backed by the authority of Babylonian gods and the state.

The stone slab on which the code was carved was discovered in Susa, Iran, in 1901. An Elamite king had carried it off as a war trophy.

Hampden, John (1594-1643), was one of the Parliamentary leaders in the English Civil War (1642-1646 and 1648). In 1626, he refused to pay a forced loan to Charles I and was jailed. Ten years later, he was again prosecuted for refusing to pay *ship money,* a tax previously levied only on coastal areas, but extended by Charles to the whole country. Hampden became a national hero.

From then on, Hampden took a leading part in Parliament's efforts to curb the King's powers. In 1642, Charles tried to arrest him and four other members. Charles failed, and the Civil War broke out. Hampden was mortally wounded at the Battle of Chalgrove Field. He was born in London.

Hampshire is a county in southern England. It faces the English Channel about halfway along England's southern coast. Gently rounded hills, fertile valleys, pleasant villages, and woodlands make the county one of the most beautiful in Britain. Traditionally an agricultural county, Hampshire has several growing centres of industry. Along the coast are seaside resorts and the large harbours of Southampton and Portsmouth. Winchester College, one of Britain's most famous independent schools, was founded in 1382 by William of Wykeham, the Bishop of Winchester. The college was opened in 1394. The University of Southampton is at Highfield, 3 kilometres from Southampton's city centre. Southampton also has a college of art, a college of maritime studies, and a college of higher education.

Facts in brief about Hampshire

Administrative centre: Winchester.
Largest towns: Southampton, Portsmouth, Havant, Fareham, Gosport, Basingstoke, Eastleigh, Aldershot, Farnborough.
Area: 3,775 km².
Population: *1991 census*—1,511,900.
Chief products: *Agriculture*—dairy products, pigs, poultry, sheep, soft fruit. *Manufacturing*—carpets, chemicals, cigarettes, computers, electrical and electronic equipment, engineering goods, oil products, packaging, plastics, shipbuilding, synthetic rubber.

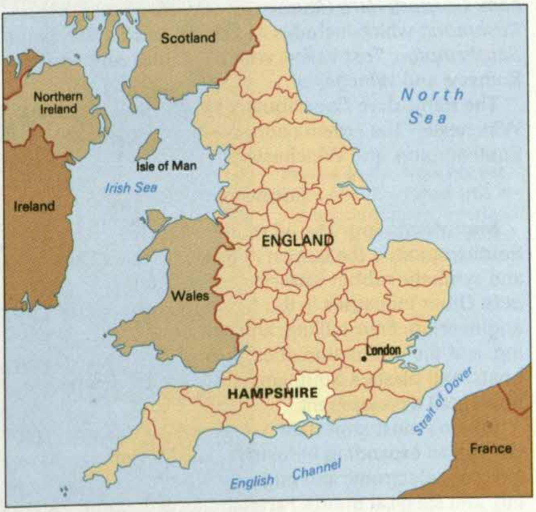
In 1974, Hampshire was reduced slightly in size. A small part of western Hampshire, including the towns of Bournemouth and Christchurch, was taken into Dorset.

The Isle of Wight, England's largest offshore island, is separated from Hampshire by a stretch of water called the Solent. For years, this island was part of Hampshire, but it is now a separate county. See **Wight, Isle of.**

People and government

Customs. The Tichborne Dole is presented each year on March 25. The villagers at Tichborne, near Alresford, receive flour that has been blessed at a special service. The custom arose in 1150, when the dying wife of Sir Roger de Tichborne wished to provide a dole for the village. He agreed to give as much land as she could crawl around while carrying a burning torch. She managed to encircle more than 8 hectares. Today this piece of land is still called *The Crawl.*

Recreation. A famous cricket club developed at Hambledon during the 1700's. Cricket is still popular in



Hampshire is a county in southern England facing the English Channel.

Fawley oil refinery lies along the edge of Southampton Water in southern Hampshire. The refinery, Britain's biggest, supplies nearby chemical and synthetic rubber factories.

the county, which has a first-class county team. Aldershot, Portsmouth, and Southampton have soccer teams in the Football League. Fishing facilities are good both in Hampshire's streams and rivers and along the coast. Sailing conditions are good, especially on the Solent, and the county has many yachting clubs and schools. Gliding, particularly in northern Hampshire, golf, and horse riding are other popular pastimes.

Local government. Hampshire has 13 local government districts: *Basingstoke and Deane; East Hampshire,* which includes Alton and Petersfield; *Eastleigh; Fareham; Gosport; Hart; Havant; New Forest; Portsmouth; Rushmoor,* which includes Aldershot and Farnborough; *Southampton; Test Valley,* which includes Andover and Romsey; and *Winchester.*

The Hampshire Constabulary has its headquarters at Winchester. The crown court meets at Portsmouth, Southampton, and Winchester.

Economy

Manufacturing. The oil refinery at Fawley, south of Southampton, is the largest in Britain. Nearby chemical and synthetic rubber factories use the refinery's products. Other industries in the Southampton area include engineering, flour milling, and shipbuilding and repairing, and the production of carpets, cigarettes, hydrofoil boats, and plastics. Southampton is the chief centre of hovercraft development.

Britain's most important naval base is Portsmouth. The city has an expanding industrial area. Its workers make clothing, electronic and engineering products, packaging, and surgical goods. Fareham has light industries, with products including aircraft and motorcar accessories, baskets, fertilizer, and flower pots. Products of the Havant area include computer and electrical equipment. Basingstoke is a road and rail centre with a large engineering works. It has attracted new industries, such as electronics, pharmaceuticals, and security printing.

Agriculture. Sheep farming, traditionally important in Hampshire, has declined in recent years. It has been replaced in many areas by growing cereals, especially barley. Dairy farming is important in some areas. Farmers rear pigs and poultry on a large scale. Hampshire's climate favours the growing of soft fruit, such as strawberries. Market gardening is an important industry. Specialized crops include watercress in the Winchester area, and hops near Alton.

Tourism is an important part of Hampshire's economy. There are many hotels and guesthouses and several holiday camps. Some farmhouses provide overnight accommodation. Southsea is a large resort, with a wide variety of amusements. Other tourist attractions include the tranquil countryside of the New Forest. Visitors can see wild ponies and other wildlife. The county has many beautiful historic buildings, such as Winchester Cathedral, the building of which was begun in the 1070's. With a length of 170 metres, it is the longest church in England and one of the longest in Europe.

Transport and communication. Main road routes from London toward Land's End pass through northern Hampshire. They are the M3 motorway, the A30, and the A303. The A34 links Southampton with the Midlands and northern England. The M27 motorway runs from Portsmouth to Cadnam, and provides a bypass for Southampton. The A33 links the M27 and the M3 motorways.

Main railway routes link Southampton with London to the northeast, and with Portsmouth and Sussex coastal towns to the east. To the northwest a line goes to Bristol, and to the west, one goes to Bournemouth and Weymouth.

Cargo ships sail from the port of Southampton to all parts of the world. Ferry services connect Lymington, Portsmouth, and Southampton to the Isle of Wight. Some of these ferry services are operated by hovercraft. Portsmouth has a car ferry service to Brittany and Le Havre, France. Southampton airport has regular flights to other United Kingdom (UK) and French airports.

Southampton has the headquarters of Meridian, an independent television company. There is also a British Broadcasting Corporation local radio station at Southampton and an independent local radio station, Ocean Sound, at Fareham. Portsmouth and Southampton have local daily newspapers and most towns publish weekly newspapers.

Land

Location and size. Hampshire borders Berkshire on the north, Surrey and West Sussex on the east, and Dorset and Wiltshire on the west. The county is roughly square, projecting in the southwest to include the New Forest. The county measures about 64 kilometres both from north to south and from east to west.

Land regions. The flat coastal area around the port of Southampton is part of a geological formation known as the *Hampshire Basin.* The curve of the basin runs under the sea and rises again to form the Isle of Wight. Southampton Water lies near the centre of the basin. It links Southampton to the open sea through the east and west channels of the Solent. In the western half of the basin is the New Forest.

In the eastern half of the Hampshire Basin are the wide harbours of Gosport, Portsmouth, and Hayling Island. The South Downs, a range of chalk hills, crosses the border from Sussex into southern Hampshire. Another line of hills forms the Hampshire Downs in the northern part of the county. The highest point in the county is at Butser Hill, 271 metres above sea level in the southeast.

Rivers. Hampshire has many rivers, but none of them are large. The Avon flows southward through western Hampshire and enters the sea at Christchurch in Dorset. In its estuary, the Avon is joined by the River Stour which flows into Hampshire from Dorset. The Beaulieu and Lymington rivers, each of which is about 19 kilometres long, flow through the New Forest.

The Test is Hampshire's longest river. It rises in the north, flows southward for nearly 64 kilometres, and flows to the sea west of Southampton. The Test is known as one of England's finest trout-fishing rivers. The Itchen, the river on which Southampton lies, flows for about 32 kilometres from near the centre of the county. Other rivers in Hampshire include the Meon, Rother, and Wey.

Climate. The coast of Hampshire is one of the driest areas in the UK. The county has more sunshine than most other parts of the UK. Rainfall averages 710 millimetres a year along the coast, 890 millimetres on the high ground in the southeast, and about 940 millimetres on the Hampshire Downs. Winters are generally mild, with little snow compared with most other parts of the UK. The county's average temperature in January, the coldest month, is about 4° C. The average temperature for July, the warmest month, is about 17° C.

Ponies in the New Forest roam free. The forest area includes much open moorland, as well as some of the oldest woodland in the United Kingdom.

Hampton Court Palace includes *grace and favour* apartments, which are residences occupied by favour of the queen. A large fire started in a grace and favour apartment in 1986.

History

People have lived in the area now known as Hampshire for thousands of years. About 4,000 years ago, they constructed *long barrows* (burial mounds) around the chalk hills where they grazed their cattle. One long barrow is at Old Winchester Hill, near Winchester.

The Romans occupied the area of the county in about A.D. 43. They built many villas (large country houses) and roads. Their road networks spread out from their main cities at Winchester and Silchester. At Silchester, remains have been found of a Christian church built during the Roman occupation.

Some years later, the Jutes, and then the Saxons, invaded the county. The Saxons founded the kingdom of Wessex and established Winchester as its capital. Birinus, a missionary from Italy, landed on the coast of Hampshire in 634. He baptized Cynegils, king of Wessex, in the following year. During the 800's, Danes plundered the area and fought many battles against the West Saxons.

Winchester became an important religious centre in the late 600's, and remained a royal residence until the late 1200's. Monarchs sometimes used Winchester Cathedral for royal occasions till the late 1500's. The city dwindled in size and importance after the plague of the 1660's had killed many of its people.

Southampton was a port during the Roman occupation. Later, the Jutes and other invaders landed either at or near Southampton. In the 800's, the area around Southampton was called the *County of Southampton.* During the Middle Ages, many military expeditions to France sailed from the port. In World War II, Southampton was a base from which the Allies sailed to invade France in 1944.

Many kings lived at Winchester. King Alfred died at Winchester and Henry III was born there. Lord Palmerston, who was twice Prime Minister, was born at Romsey. Among other well-known people who lived in Hampshire was Isambard Kingdom Brunel, the engineer and ship designer, who was born at Portsmouth.

Many well-known British writers lived in Hampshire. Jane Austen lived at Chawton and died at Winchester. Charles Dickens was born in Portsmouth. Gilbert White, the naturalist and author of the classic book *Natural History and Antiquities of Selborne* lived at Selborne, near Alton. Charles Kingsley, a famous clergyman and author of *The Water Babies,* lived and died at Eversley, near Fleet.

Related articles in ***World Book*** include:

Alfred the Great
Austen, Jane
Dickens, Charles
Great Plague
Kingsley, Charles
New Forest
Palmerston, Viscount
Silchester
Solent
Southampton
Test valley
White, Gilbert
Wight, Isle of

Hampton, Lionel (1913-), an American jazz musician, became the first major jazz stylist on the vibraphone. Hampton established the vibraphone, often called the *vibraharp* or simply the *vibes,* as an accepted jazz instrument.

Hampton gained fame playing with clarinetist Benny Goodman from 1936 to 1940. Hampton's rhythmic drive plus his enthusiastic showmanship, made him a major attraction. He occasionally played drums and piano as well. From 1937 to 1940, Hampton led small groups of musicians from famous bands in a number of recording sessions. Many records by these groups rank as jazz classics.

Hampton formed his own band in 1940 and has led bands almost continually ever since. His 1942 record of "Flyin' Home" was a great success, and all of Hampton's bands have featured this tune. Hampton was born in Louisville, Kentucky, U.S.A.

See also **Jazz** (picture: Benny Goodman).

Hampton Court is a royal palace on the bank of the Thames in southwest London, opposite Kingston upon Thames. The grounds and the state apartments are open to visitors.

Hampton Court was begun by Cardinal Wolsey in 1515 and given by him to Henry VIII in 1526. Wolsey's part of the palace includes the Tudor gatehouse, the great hall, which has a magnificent hammerbeam roof, and the chapel. The Tennis Court, still used for the game of royal tennis, was built by Henry VIII. William III and Mary II planned to rebuild the palace and employed Sir Christopher Wren to do this. Wren rebuilt only the east part, a vast suite of state apartments surrounding a courtyard called Fountain Court. The beautifully laid-out gardens include a maze.

See also Grace and favour.

Hampton Court Conference was a meeting called in 1604 by King James I of England. Its purpose was to settle the disputes between the Puritan and High Church parties of the Church of England.

The conference lasted for three days and resulted in a few changes. But it failed entirely to bring about the reforms desired by the Puritans, and actually made their position more difficult. An important indirect result of the conference was the revision of the Bible called the *King James,* or *Authorized, Version.* It first appeared in 1611. See **Bible** (The King James Version); **James** (I).

Hampton Roads, Battle of. See **Warship** (Warships of the 1800's); **Monitor and Merrimack.**

Hamster is any of several kinds of small, chunky, furry rodents that live in Europe and Asia. Most kinds of hamsters have a short tail and large cheek pouches in which they can carry a great amount of food. There are about 15 kinds of hamsters. The best-known species are the *golden hamster* and the *common hamster.*

The golden hamster, also called the *Syrian hamster,* has light reddish-brown fur on its back and white fur on its underside. Golden hamsters measure about 18 centimetres long and have a short tail that is 13 millimetres long. They weigh about 110 grams.

The common hamster is also called the *black-bellied hamster* because it has black fur on its underside. Common hamsters measure about 28 centimetres long and weigh up to 900 grams.

Golden and common hamsters live alone and are active mostly at night. They dig burrows that have separate compartments for nesting, food storage, and body wastes. Hamsters eat many kinds of food, including fruits, seeds, green vegetation, and some small animals.

A female golden hamster carries her young in her body for 16 days, and the common hamster carries hers for 16 to 20 days. Both species generally give birth to six or seven young. Wild females usually have two litters a year, but they may give birth as often as once a month in captivity. Newborn hamsters are completely helpless and are cared for by their mother for about three weeks.

Golden hamsters are popular pets. Pet hamsters should be kept in metal cages or in glass or plastic enclosures. Wood shavings, dried grass, or some other absorbent material should line the cage floor. Hamsters may be given many kinds of food, including fruit, raw vegetables, small grains, whole or rolled oats, and some meat. They need fresh water. Pet hamsters live three to four years.

Scientific classification. Hamsters belong to the rodent family Cricetidae. The golden hamster is *Mesocricetus auratus,* and the common hamster is *Cricetus cricetus.*

Hamstring. See **Leg** (The thigh).

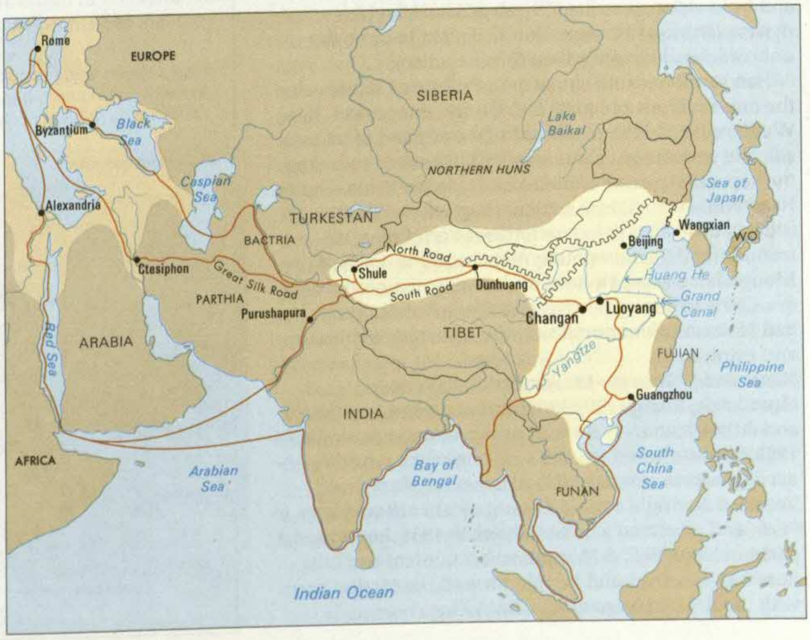
Hamsun, Knut (1859-1952), was a Norwegian author who wrote about nature and the land. He won the 1920 Nobel Prize for literature for his novels. His best-known novel, *The Growth of the Soil* (1917), describes the life of peasants in rural Norway. His early novels, *Hunger* (1890), *Mysteries* (1892), and *Pan* (1894), study those who have been rejected by society.

Hamsun was born in Lom, Norway. He had little formal education and spent most of his early adult life wandering from job to job. Hamsun favoured a strong central government that would control society. He supported the World War II German occupation of Norway, and was later fined for pro-German activities. However, his powerful novels transcend the limitations of his political views.

Han dynasty was a series of emperors of the same family who ruled ancient China for over 400 years.

The Han Empire about A.D. 100

This map shows the Han Empire at its greatest size. A major expansion occurred about 100 B.C., when the empire was extended west into central Asia. Then, for the first time in history, overland trade routes linked China with Europe. About A.D. 100, Han armies conquered land north of the Great Wall.



Under Han rule, arts and sciences thrived and China became as large and as powerful as the Roman Empire. The Chinese still call themselves Han people in recognition of China's achievements during this period.

Liu Bang (also spelled Liu Pang) founded the Han dynasty in 202 B.C., after the fall of the Qin (Ch'in) dynasty (see **Liu Bang**). The Han rule was divided into two periods. The *Former* Han dynasty lasted from 202 B.C. to A.D. 8. Its capital was Chang'an (now Xi'an). The *Later* Han dynasty lasted from A.D. 25 to 220, and its capital was Luoyang. Because Chang'an lay west of Luoyang, the two periods are also called the *Western* and *Eastern* Han dynasties. From A.D. 8 to 23, China was ruled by Wang Mang, a revolutionary who set up the Xin (Hsin) dynasty. After the Xin fell, the Han regained control.

Han emperors after Liu had a strong centralized government. Confucian scholars held important government positions. Emperor Wudi, who ruled from 140 to 87 B.C., made Confucianism the state philosophy (see **Confucianism**).

During the Han rule, a central university was built in Chang'an. Han poets and prose writers developed a clear style that is still famous. Scholars wrote long histories of China. Artists produced glazed pottery and large stone carvings.

Han China expanded southwest to what is now Tibet. Han warriors also conquered what are now North Korea and northern Vietnam and overcame nomadic tribes in the north and west. Overland trade routes linked China with Europe for the first time. Along the most famous route, the Great Silk Road, Chinese silk and other products flowed into the Roman Empire.

The Han dynasty collapsed because of rivalries among the scholar-officials, imperial relatives, advisers, and generals. For the next 400 years, China was divided into warring states.

See also **China** (History [The early empire]).

Han Kao-tsu. See **Liu Bang.**

Han Wudi (156-87 BC), a Chinese ruler of great talent and bold vision, was the fifth emperor of the Han dynasty. During his reign, Confucianism became the only official philosophy (See **Confucianism**).

Han Wudi became emperor at the age of 16. He ruled the country from 140 to 87 B.C. During this period, Han Wudi introduced state control of money and of trade in salt and iron. He gave out favours by decree to weaken the separatist power of dukes and princes in his empire. Han Wudi sent military leaders to attack the Xiongnu (Hun), a tribe then living in northwestern China. His troop forced the Xiongnu to migrate to the north of the Mongolian Desert. He sent diplomatic missions to western China to strengthen his rule there. In later years, he had fantasies of immortality and became superstitious and extravagant.

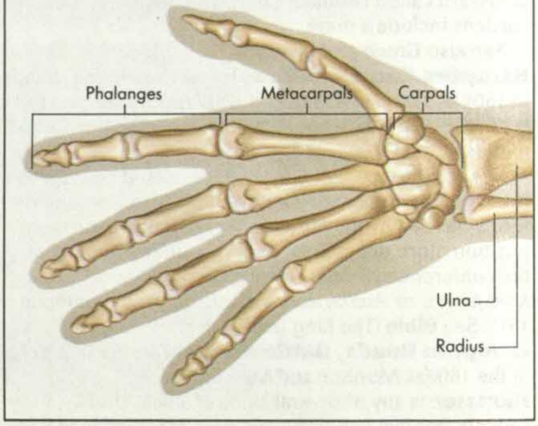
Hancock, George W. See **Softball** (History).

Hancock, Lang (1909-1992), an Australian prospector and farmer, pioneered aerial prospecting in Australia. In 1952, he discovered from the air one of the world's richest deposits of iron ore in the Hamersley Ranges of Western Australia. Langley George Hancock was born in Perth and educated at Hale School. In 1935, he formed a partnership with E. A. Wright, an accountant and businessman. Hancock and Wright formed Hamersley Iron with the British company Rio Tinto Zinc.

Anatomy of the hand

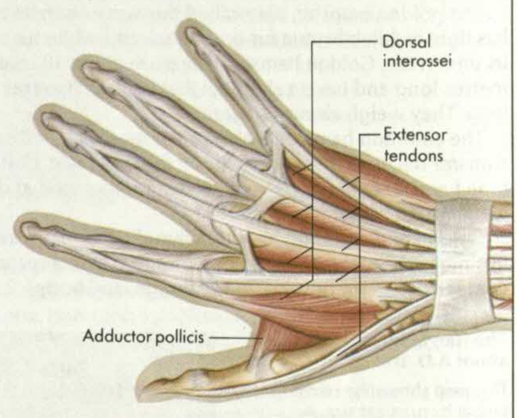
Bones of the hand

Right hand (palm up)

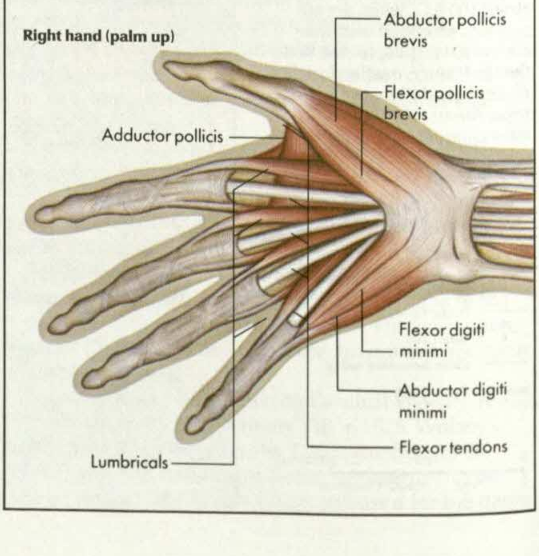


Muscles of the hand

Right hand (palm down)



Right hand (palm up)



Hand is the end of a *forelimb,* or arm. Hands are specially constructed for taking hold of objects. True hands have *opposable thumbs,* or thumbs that can be moved against the fingers. This action makes it possible to grasp things in the hand and make many delicate motions. Human progress would have been hampered without the use of opposable thumbs. To help understand the work that thumbs do, try to pick up a pen without moving your thumb.

Hands are also used to touch and feel things. The human hand contains at least four types of nerve endings that make the fingers and thumbs highly sensitive. Blind persons rely entirely on their sense of touch when reading. They run their fingers over the raised letters of Braille books.

The human hand also helps people communicate with each other—as in the sign language of the North American Indians or that of deaf persons. In these sign languages, gestures and positions of the hand and fingers represent words or phrases. Hands convey familiar expressions and ideas. Well-known examples include the clenched fist of anger, the raised palm of peace, the "V" for victory, and the "thumbs down" for disapproval.

Parts of the hand. The human hand consists of the *carpals* (wrist bones), the *metacarpals* (palm bones), and the *phalanges* (four fingers and thumb). There are 27 bones in the hand. Eight carpal bones make up the wrist. They are arranged roughly in two rows. In the row nearest the forearm, starting from the thumb side, are the *scaphoid, lunate, triquetrum,* and *pisiform* bones. In the second row are the *trapezium, trapezoid, capitate,* and *hamate* bones. There are five long metacarpal bones that make up the palm. They connect the wrist with the fingers and thumb. Each of the four fingers contains three slender phalanges. But the thumb has only two phalanges.

Thirty-five powerful muscles move the human hand. Fifteen are in the forearm rather than in the hand itself. This arrangement gives great strength to the hand without making the fingers so thick with muscles that they would be difficult to move. Near the wrist, the muscles become strong, slender cords called *tendons.* The tendons run along the palm and back of the hand to the joints of the fingers. When the muscles on the palm side of the forearm contract, the fingers close. When the muscles on the back of the forearm contract, the fingers open. Twenty muscles within the hand itself are arranged so that the hand and fingers can make a variety of precise movements.

A hand organ produces music when a player cranks a handle. Street musicians played a type of hand organ called a *barrel organ,* such as the one shown below in London about 1905.

Animal hands. In many animals, part of the forelimb corresponds to the human hand. These parts have the same basic arrangement of bones and muscles whether the animal uses them to dig, fly, swim, or run. No animal "hand" has more than five digits. Animals have many kinds of "hands." The mole's short, chunky "hand" is ideally suited to act like a shovel in digging tunnels. The bat's forelimb is a wing, with a web of skin spread between the fingers. The bird's "hand" is also a wing. Phalanges and metacarpals support the wing. The seal's "hand" is its flipper. The bones have *fused,* or grown together, and form a broad, flat paddle useful for swimming. The "hand" of the horse is constructed so that the animal stands on its middle finger. Through millions of years of development, the middle finger has become stronger and longer. The tip of the finger is protected by the strong, curved hoof. It is well adapted to running. The horse's other fingers have become quite small or have disappeared.

Hand grenade. See Grenade.

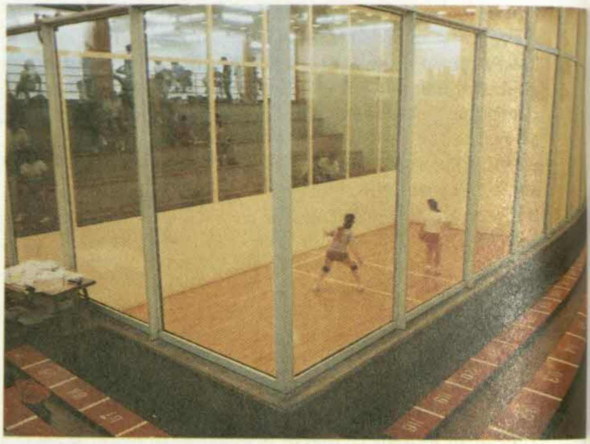
Hand organ is the general name given to several kinds of musical instruments that produce music when the player cranks a handle. The most common kind is the *barrel organ,* or *piano organ,* played by street musicians. It consists of a box that contains pipes or metal reeds and a cylinder, called a *barrel,* on which pegs are arranged. When the barrel is turned, the pegs open the valves of various pipes. The cranking action forces air into the open pipes to produce music.

The *hurdy-gurdy* is a kind of hand organ with strings that is seldom played today. Most hurdy-gurdies have from four to six strings. The instrument is played with keys and a rosin-covered wooden wheel. The keys determine the notes that are played. The wheel, turned by hand, rubs the strings to create the music. The hurdy-gurdy was popular in Europe during the 1000's and again during the 1700's. The Austrian composer Joseph Haydn wrote several works for the hurdy-gurdy.

Handball is a fast and exciting sport for men and women in which players try to score goals by throwing a ball into their opponents' goal. Team handball can be played indoors or outdoors. Modern team handball at the international level is an indoor game. This article describes the indoor version that has been an event in the Summer Olympic Games since 1972.

Teams consist of seven players—six court players and a goalkeeper. A team handball court is 40 metres long and 20 metres wide. A goal line runs the width of the field at each end. Side lines enclose the playing area lengthwise. A goal is centred lengthwise on each goal line. It consists of two posts 2 metres high and 3 metres apart. The posts are connected by a horizontal bar. A net is attached to the posts and bar. The ball in men's competition is 58 to 60 centimetres in circumference. The ball in women's games is slightly smaller.

Handball is an international team game with seven players on each side. It resembles soccer but the players use their hands to pass the ball.



An Irish handball court usually has walls on all four sides. A maximum of four people play in a game. The game is popular in Ireland and the United States.

Games are divided into two 30-minute periods. Many of the rules resemble soccer rules except that players can use their hands but cannot use their feet to pass and dribble the ball. Two referees supervise play.

A different game of handball developed in Ireland. Irish handball has been popular in Ireland since pre-Christian times and is similar to a game that was played by ancient Egyptians. Irish emigrants took their form of handball to the United States and Canada, where it also became popular.

Irish handball is played as *singles* (with two people) or as *doubles* (with 4 people). Irish handball is played on courts with four walls, three walls, or one wall. *Four-wall handball* is the most popular form. A standard four-wall court is 6 metres high, 6 metres wide, and 12 metres long. Its back wall must be at least 3.7 metres high.

Three-wall handball has the same playing area and rules as four-wall, but there is no back wall. Some three-wall courts have ceilings.

One-wall handball originated in New York City. It is usually played outdoors. It is the only type of handball in which players can take a stationary block position against the opponent. A standard court is 6 by 10 metres. Its wall is 6 metres high.

To begin the game, the server stands in the *service box* (a zone 1.5 metres wide near the middle of the handball court). The server drops the ball on the floor and strikes it with one hand on the first bounce, driving the ball against the front wall. The ball must strike the front wall of the court before hitting the floor or ceiling or another wall. After hitting the front wall, the ball must bounce back over the *short line* (centre line across the width of the court). The serve may hit one side wall after hitting the front wall, but must go over the short line before it hits the ground. A serve that falls in front of the short line is a *short,* and the server serves again. If the server hits another short, it is considered an *out,* and the other team takes over the serve.

After a serve comes over the short line properly, the server's opponent hits the ball if possible. The players or teams then take turns hitting the ball against the front wall until one of them fails to return the ball before it bounces twice on the floor. Players cannot *hinder* (block) each other from hitting the ball. In returning a ball, a player can use a combination of side walls or ceiling with the front wall, or can hit the ball directly into the front wall. If the server misses a returned ball, the serve is lost. If the opponent misses, the server scores 1 point and serves again. The first side to score 21 points wins the game. A *match* usually consists of the best two out of three games.

Handcuffs are used by police officers to prevent a suspect or prisoner from having full use of the hands. Most handcuffs consist of a pair of steel rings connected by a short chain. The rings fit over a person's wrists and can be adjusted to fit wrists of different sizes. One end of each ring has jagged edges that slip into the other end and lock automatically. Such handcuffs are opened with a key.

Another kind of handcuff is a 56-centimetre strip of inexpensive flexible plastic. One end is slipped through a slit at the other end. A small steel hook near the slit locks the ends together. These handcuffs are removed by cutting them off.

In ancient times, handcuffs were called *shackles* or

Handcuffs commonly consist of two metal rings connected by a chain. They are designed to limit a person's hand movement.

manacles. They were used either as a form of punishment or as a method of fastening both the hands and feet of a suspect or prisoner.

Handel, George Frideric (1685-1759), was a German-born composer who is known today mainly through his musical compositions called *oratorios.* His famous oratorio *Messiah* is one of the most popular works in music. In the mid-1900's, Handel's operas, neglected for 200 years, gained recognition as at least equal in quality to his oratorios. Handel also composed much orchestral music, *chamber music* (music for small groups of instruments), and solo music for harpsichord.

His life. Handel was born on Feb. 23, 1685, in Halle, Germany. He began taking music lessons at the age of 7. By the time he was 12, he was assistant organist at the Halle cathedral. As a youth, he had a typical Lutheran education and studied law at the University of Halle for a year. His earliest activity as a composer began in 1703 in Hamburg, at that time a centre of French, Italian, and German operatic styles.

Between 1706 and 1710, Handel worked in Italy, becoming one of the most popular composers of Italian opera. In 1710 and 1711, he served briefly as Director of Music in Hanover, Germany. He moved to England in 1712 and lived in London until his death. He is buried in Westminster Abbey.

Italian opera was still quite new to England when Handel arrived and it gained its greatest popularity among the nobility during his early years there. Then the flourishing middle class flocked to the English ballad operas, and the nobility turned to the lighter and often comic operas of the younger Italians.

In 1741, Handel abandoned opera and dedicated himself to composing oratorios. *Messiah* was the first of the oratorios that followed. In 1751, after completing *Jephtha,* Handel gave up composing because of blindness. But he remained active. He conducted a Holy Week performance of *Messiah* the day before he died.

His work. The oratorio developed in Italy as a music drama to be played without staging in the *oratory* (meeting room) of a religious association. Singers represented characters in a Biblical story or in the life of a saint. In addition to the dialogue and songs of the singers, a narrator often filled in necessary details in the story. A chorus usually represented groups of people or crowds and reacted to the events.

Handel based almost all of his oratorios on Biblical stories, favouring the Old Testament. *Messiah* is an exception. The text is a collection of quotations gathered by Handel's friend Charles Jennens from the Bible. *Messiah* contains no dramatic action. It illustrates the foundations of Christianity in a series of musical pieces that parallel the prophecy of Christ's coming, His birth, life, death, and resurrection.

The music of the solo singers in the oratorios was written in the manner of Italian opera of that time. The choruses often use the style of the sacred anthem. Most of Handel's oratorios were first performed in theatres. Audiences paid admission as they would to an opera. *Messiah* was first heard in a theatre in Dublin in 1742.

The main reason for the popularity of *Messiah* lies in its glorious choruses. There are more inspired choruses in *Messiah* than in any of Handel's other oratorios, and they use a remarkable variety of mood and technique. "And the glory of the Lord" is a happy dancelike chorus in triple time. The voices come in and out casually and also join in resounding exclamations. In "And He shall purify," the four voice parts take turns singing the theme. "O thou that tellest good tidings" recalls earlier English music, particularly that of Henry Purcell, in its melody, lightness, and good cheer. In "Surely he hath borne our griefs," Handel portrayed grief with solemn rhythms and thick harmony. The thrilling "Hallelujah" chorus shows Handel as a master of choral effects, particularly in dividing a chorus into two groups singing different themes.

George Frideric Handel

Saul (1739), Handel's most dramatic oratorio, is more typical of Handel's approach to the oratorio. Jennens' words represent the conflict between Saul, King of Israel, and David, the youthful warrior who slew Goliath. The action develops during the sections of speechlike song called *recitative.* These sections are usually accompanied only by a harpsichord and violoncello. The characters express their anger, hope, love, delight, joy, and other emotions in lengthy *arias* (solos) accompanied by orchestra. The reasons for these emotional outbursts are brought out in the recitative. The two types of music alternate unless a chorus or symphony breaks in. The arias often rely on the *da capo* formula. In this formula, the first section, based on one theme, returns after a middle section based on a similar or contrasting theme.

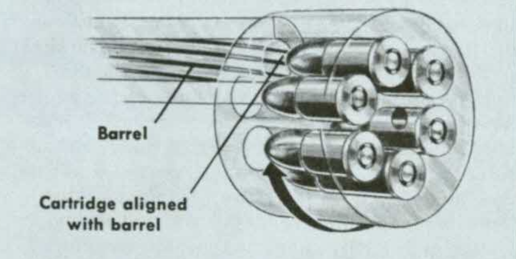
Few of the choruses of *Saul* are of the meditative, anthemlike variety of *Messiah.* They tend to be shorter and more direct. Like the chorus of Greek tragedy, they provide emotional reactions to dramatic events. Sometimes they point out a moral.

Handel's more than 40 operas were mostly written before *Saul.* Modern productions of his operas *Julius Caesar* (1724) and *Alcina* (1735) demonstrate that they are still stageworthy and appealing, filled with melodic invention and emotional variety. They have earned Handel a place among the world's great dramatic composers.

Handel wrote more than 150 instrumental compositions. The best known of these include two orchestra suites, *Water Music* (about 1717) and *Fireworks Music* (1749). Handel composed many harpsichord suites, organ concertos, and sonatas for chamber groups. He also wrote a number of *concerti grossi,* compositions that feature a small group of soloists against the background of a string orchestra.

Handgun is a firearm that is operated with one hand. Other types of guns, such as rifles and machine guns, require the use of both hands, a *tripod* (three-legged stand), or a shooting rest.

Handguns are carried primarily by the armed forces, and in many countries by the police. But in almost every country of the world their use by civilians is greater than their use by government agencies. Handguns are extensively used for sporting and target shooting



A revolver cylinder usually has six chambers to hold the cartridges. Cocking a revolver rotates the cylinder so the next cartridge aligns with the barrel.

and, in many countries, for the protection of the individual and his property. 55 million handguns are owned by private citizens in the United States. The incidence of firearms ownership in some other countries, Switzerland, for example, is even higher.

Parts of a handgun

Handguns vary in appearance, size, type of ammunition used, and method of operation, but they all include the same basic parts. These parts are the *frame*, the *grip*, the *barrel*, the *sights*, and the *action*.

The frame is the main body of the gun that connects the other parts. The grip is the handle of the gun, and the barrel is the metal tube through which the bullet is fired. The *lands* and *grooves* are alternating raised surfaces and channels inside the barrel. They cause the bullet to spin and thus make it travel in a direct path.

The shooter uses the sights to line up the handgun with the target. Many handguns made for target shooting have adjustable sights.

The action includes the main working parts of the handgun. It consists of such parts as the trigger, the hammer, and the cartridge chamber. The type of action a handgun has determines how it is loaded and fired.

Types of handguns

There are five main types of handguns: (1) single-action revolvers, (2) double-action revolvers, (3) single-action semiautomatic pistols, (4) double-action semiautomatic pistols, and (5) single-shot pistols. Revolvers carry ammunition in chambers in a rotating cylinder. Most pistols are loaded with *magazines* of ammunition. Magazines are metal holders inserted in the gun's *butt* (thicker end).

Single-action revolvers generally hold six cartridges. An arm near the hammer rotates the cylinder one-sixth of a turn when the hammer is cocked. This movement puts a cartridge into line with the barrel and the *firing pin* (part that strikes the primer to fire the cartridge). After cocking the hammer, the shooter pulls the trigger. The hammer unlocks and falls, firing the cartridge. The American Colt single-action Army revolver, produced during the mid-1800's, is the most famous weapon of this type.

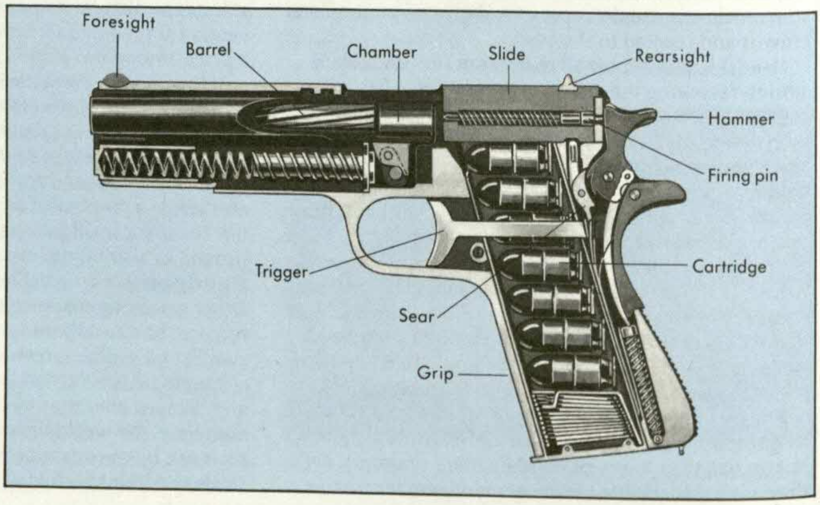
Double-action revolvers, like single-action revolvers, generally hold six cartridges. But, unlike single-action revolvers, double-action revolvers do not require the user to cock the hammer manually before firing. Instead, the gun may be fired simply by the action of pulling the trigger. When the trigger is pulled, a lock that holds the cylinder in place is released and the cylinder revolves. When the next chamber is lined up with the barrel, the cylinder locking bolt is raised into the locking notch, securing the cylinder. The hammer then falls and fires the cartridge. The cycle is repeated for the next shot.

The main advantage of the double-action revolver over the single-action revolver is that it can be fired more rapidly. The Smith & Wesson military and police revolver is one of the most popular American double-action revolvers. This weapon was first introduced in 1905.

Single-action semiautomatic pistols are fired by first pulling back a device called a *slide* to cock the hammer. When the slide is released, it moves forward and feeds a round from the magazine into the cartridge chamber. When the shooter pulls the trigger, the hammer falls, striking the primer and exploding the gunpowder in the cartridge. The explosion causes the slide to move backward. This *recoil* automatically removes the empty cartridge and recocks the gun. When the

How an automatic handgun works

The Colt .45 automatic pistol was primarily designed for personal defence. This weapon is fired by first pulling the slide to the rear to cock the hammer. Releasing the slide feeds a cartridge into the chamber. When the trigger is squeezed, it presses against the sear, which in turn releases the hammer. As the hammer falls, it strikes the firing pin. The firing pin flies forward, striking the primer of the cartridge and firing the cartridge. Recoil drives the barrel and slide to the rear, automatically cocking and loading the pistol for the next shot.



slide moves forward again, it reloads the chamber. A famous single-action semi-automatic pistol is the German *Parabellum* (also known as the Luger). The Parabellum was adopted for service by the German Army in 1908. However, it is now generally regarded as obsolete for defensive use.

Double-action semiautomatic pistols operate somewhat like double-action revolvers. When the trigger is pulled, the hammer goes through the firing cycle and fires the cartridge. After the initial shot, the pistol operates like a single-action semiautomatic pistol. The recoil of the first shot ejects the empty cartridge case, cocks the hammer, and loads a new cartridge from the magazine into the cartridge chamber. The double-action semi-automatic in its various forms is now widely accepted as the standard design for service handguns. The popularity of the double-action semi-automatic dates from 1929, with the introduction of the extremely successful German Walther Model PP (*Polizei Pistole* or Police Pistol). In 1938 the German Army adopted another double-action Walther pistol, the P.38, as its service weapon. This established the Walther double-action as the most influential design for service and police pistols.

Single-shot pistols are used chiefly in international target-shooting competitions. To load a single-shot pistol, the user moves the *operating lever* (part that opens and closes the action) forward and down to lower the *breech block* and to cock the firing pin. The breech block closes the *breech* of the gun—that is, the part behind the barrel. After the breech block has been lowered, the cartridge chamber is exposed. The user then inserts a cartridge into the chamber. Next, the operating lever is pulled up and back to close the chamber and move the cartridge into the closed position. The pistol is then ready to fire. When the trigger is pulled, the firing pin drops, firing the cartridge. The procedure is then repeated to remove the cartridge and reload the pistol. Famous single-shot pistols include the Hammerli Free Pistol, the Walther, and the Martini.

History

Early handguns. The first gun that could be operated with one hand was the matchlock gun, which appeared in the 1400's. It was fired by attaching a burning cord or match to the end of an S-shaped holder called a *serpentine*. In the early 1500's, the wheel-lock gun was invented. Its metal wheel struck a spark when it revolved against a piece of pyrite. With the wheel lock, soldiers no longer had to carry flames to ignite the powder in their guns.

During the mid-1500's, snaphance pistols, which were easier to operate than the wheel lock, came into widespread use. In the 1600's and 1700's, many kinds of gunlocks were developed, including the flintlock (see **Flintlock**). In 1807, Alexander Forsyth, a Scottish inventor, introduced the percussion system. Percussion system pistols were loaded from the muzzle. Small handguns called derringers are descended from percussion-cap pistols, but are breech loaded. They are named after Henry Deringer, Jr., a U.S. pistol maker of the 1800's.

Rapid-fire handguns. One of the first practical revolvers was the Colt Paterson, patented in England in 1835 by Samuel Colt, a U.S. inventor. In 1857, the U.S. inventors Horace Smith and Daniel Wesson began producing revolvers that used cartridges.

The Borchardt, the first self-loading semiautomatic pistol, appeared in 1895. It was loaded with an eight-cartridge magazine placed in the hollow of the grip. Georg Luger, an Austrian-born inventor, improved the Borchardt in the early 1900's. In 1897, John M. Browning, a U.S. inventor, patented an automatic pistol that became the basis for later automatics, including the Colt .45.

Gun control

People who favour handgun control laws believe these laws reduce crime and handgun-related deaths. Many of them say there are no legitimate reasons for

Some historic handguns Since handguns first appeared in the 1400's, certain models have become well known because of their special features, wide use, or both. Some of these handguns are shown below.

English wheel lock (1640)

English belt flintlock (1800)

First Colt (1835)

Colt Walker (1847)

Derringer (1855)

Single-action Army revolver (1873-1940)

German Luger (1908)

Colt .45 semiautomatic pistol (1911-)

private ownership of handguns. Opponents of handgun control say handguns have many legitimate uses. They argue that laws against owning handguns affect only law-abiding citizens and not criminals.

Related articles in *World Book* include:

Ammunition
Browning, John M.
Bullet
Cartridge
Colt, Samuel
Firearm
Gun
Gun control

Handicap is a way to equalize sports competition between opponents who are unequal in ability. Handicaps include scoring bonuses and weight allowances.

Handicapped is a term used to describe people who have a physical or mental disability that interferes with their leading a happy, productive life. Physical disabilities include blindness, deafness, deformity, muscular and nervous disorders, paralysis, and loss of limbs. There are two general kinds of mental disabilities, mental illness and mental retardation.

A disability may or may not be a handicap. It becomes a handicap if it interferes with the person's expectations, job performance, or relationships with his or her family, friends, and society in general. People with a similar disability may not be equally handicapped. For example, a history professor may not be greatly handicapped by the loss of a finger. But the same disability would be a terrible handicap to a concert pianist.

Many common handicaps result from diseases. Heart disease may permanently decrease the victim's strength and endurance. Strokes may produce paralysis and loss of speech. Arthritis and many bone diseases can lead to deformity. Certain nerve diseases may result in blindness, deafness, and lack of coordination. Cerebral palsy is a disorder that damages the brain before, during, or after birth. Depending on what part of the brain is damaged, cerebral palsy can cause speech problems, mental retardation, muscular weakness, or involuntary movements of the arms and legs. Accidents cause a wide range of handicaps, including spinal damage and loss of limbs.

With proper motivation and special training, even the most severely handicapped people can lead productive, fulfiling lives. Many famous people have overcome handicaps to make important contributions to mankind. The English poet John Milton was blind when he wrote his epic masterpiece, *Paradise Lost.* The great German composer Ludwig van Beethoven wrote much of his finest music after he became deaf. Franklin D. Roosevelt, paralysed in both legs by polio at the age of 39, became president of the United States. The American Helen Keller became blind, deaf, and mute before she was 2 years old, but she learned to read, write, and speak. She devoted her life to helping the deaf and the blind. Christy Brown, an Irish author and poet, was born with cerebral palsy. He taught himself to write with his left foot. His autobiography, *My Left Foot,* was published in 1954 and has been made into a film.

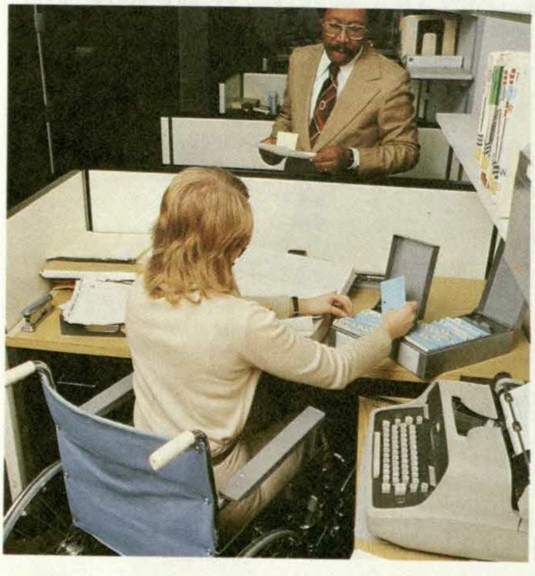
Problems of the handicapped

A handicapped person faces special problems that may affect his or her personal life, family life, and community life.

In personal life. A major problem of many handicapped people is their limited ability to perform ordinary daily activities. For example, a person with only one arm may have trouble getting dressed and undressed. An individual who has a hearing disability may have difficulty using the telephone. Some handicapped people lack the ability or energy to get around without assistance.

Handicapped individuals also may experience special psychological problems. They may become depressed because their disability makes them different from most people. However, some handicapped persons consider their disability as a challenge, and this attitude helps them overcome the handicap.

Social relationships can be difficult for the handicapped. Many nonhandicapped people do not like to be reminded that disabilities exist. As a result, they may feel uncomfortable in the presence of a handicapped indi-



Handicapped people can lead complete lives in spite of their disabilities. A woman confined to a wheelchair, *left,* holds a responsible office job. American football players at a college for the deaf, *above,* practise to the low-frequency beat of a drum. Before each play, the members of the attacking team agree that the play will begin on a certain beat of the drum.

vidual. One of the most important things a disabled person must learn is how to put others at ease.

In family life. A family's home life may change considerably if some member becomes handicapped. Previously, various members of the family had filled certain roles in the household, and difficulties can arise if these roles change. For example, adjustment problems may occur if the parent who provides the family's income suffers a stroke and can no longer do so. Severe depression could result if the other parent must get a job and take over that responsibility as head of the family. In addition, the children may have trouble accepting the new roles of their parents.

Other members of a family should not try to do too much for the disabled member. Handicapped people need to feel independent and should be allowed to solve their own problems whenever possible. If a handicapped person is overprotected or given extra attention, other family members may feel jealous and resentful. The other family members should let the handicapped member know they realize he or she has hopes, goals, and ambitions, just as they have.

In community life, the ignorance of most individuals creates problems for the handicapped. The majority of people do not realize how much a disabled person can achieve. As a result, they may exclude the handicapped from community activities, such as athletic events and theatrical productions. Some employers hesitate to employ a handicapped person because they believe the handicapped are poor workers. Actually, work records show that handicapped men and women work as well or better than other people in the same job. The handicapped also keep their jobs longer.

Because of their limited ability to move around, many

Aids for the handicapped

Handicapped individuals may require special aids to perform everyday activities. Many public buildings provide structural aids that give the handicapped access to certain places and facilities. Various aids also enable the handicapped to enjoy television and other conveniences.

The wheelchair symbol, *above,* appears on signs marking special facilities for the handicapped. Such facilities include ramps that enable wheelchair users to enter and leave a building alone.

Braille numbers in lifts make it easy for a blind person to locate the button for a certain floor.

Captioned television programmes enable the deaf to enjoy TV as completely as possible. Printed dialogue appears on the screen during such programmes.

A low telephone enables people in wheelchairs to make calls easily. Other aids for wheelchair users include low drinking fountains and toilets in wide stalls.

disabled people may lack access to certain places and facilities. At school, for example, a pupil or teacher in a wheelchair needs ramps instead of stairs, toilets with wide stalls, and other structural aids. Such aids for the disabled are provided in increasing numbers of public buildings. However, accessibility in housing and public transportation remains a serious problem.

Overcoming handicaps

Few disabilities can be cured, and so most disabled people must learn to live with their handicap. To overcome a disability, an individual must desire to be independent. Without this desire, the help of others has little value and the degree of disability remains high.

Many types of professional assistance are available to help the handicapped conquer their disability. There are three vital areas in which experts can provide help: (1) rehabilitation medicine, (2) special education, and (3) vocational training.

Rehabilitation medicine is a branch of medicine that helps improve the condition of disabled people. In most cases, rehabilitation is carried out in a hospital by a team of specialists headed by a physician. These specialists may include nurses, psychologists, social workers, speech therapists, and various other helpers.

The treatment used in rehabilitation depends on the patient's disability. Surgery can help certain kinds of blindness, deafness, and deformities. Drugs may be used to treat severe depression and other mental illnesses. Many handicapped people benefit from *physiotherapy,* which involves treatment by such means as heat, light, and water. Physiotherapy may also include special exercises that restore the patient's endurance and muscle strength.

Occupational therapy helps overcome or reduce handicaps by teaching patients various skills. These skills help disabled people gain confidence in their ability to live a full and normal life. For example, a person who has lost both legs may learn how to drive a specially equipped car.

Various mechanical devices also help the handicapped lead more complete lives. Paralysed people can move around in electric wheelchairs. Artificial arms and legs can be made to replace lost limbs. Hearing aids greatly improve the hearing of people afflicted by certain types of deafness.

Special education is instruction designed to help handicapped children use their full learning ability. It includes instruction in the classroom, at home, and in hospitals and specialized institutions. In the United Kingdom, for example, two-thirds of handicapped children attend an ordinary school.

Teaching handicapped children requires special skills and materials. A specially trained teacher may be needed to teach mentally retarded children to care for themselves and to instruct them in basic school subjects. Partially sighted children may require books with large print. Blind children learn through braille books and *talking books* (recordings on records or tapes).

Vocational training prepares the handicapped to hold a job. Specialists called *vocational counsellors* know what type of skills a person needs to succeed in a particular job. These experts conduct tests to determine a disabled person's abilities and interests. After a vocational counsellor decides what kind of work might be best for a handicapped individual, the patient can be trained for that work. A blind person may be taught to devise programmes for computers. A person confined to a wheelchair may be trained to hold an administrative position with a business company. New technological developments, such as microcomputers, electronic text scanners connected to speech synthesizers, word processors that magnify text, and many other specially developed tools have increased the number of disabled people that lead full professional lives.

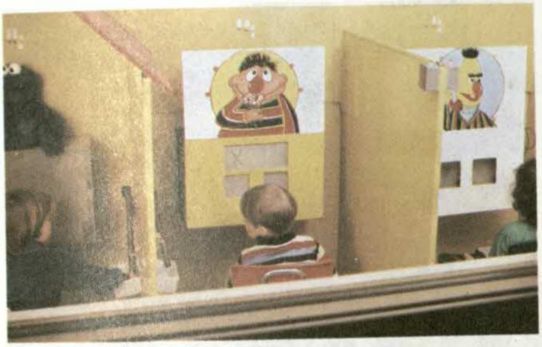
Attitudes toward the handicapped

In ancient times, hardly anyone helped the handicapped. The welfare of a group depended on the ability of each member to fight and to work. Handicapped people who could not fulfil their responsibilities threatened the safety of all, and many were driven away and left to die. Most ancient peoples believed that evil spirits caused injury or disease. The Spartans let deformed newborn children die of exposure. In Rome, a disfigured infant could be legally drowned by its parents.

During the Middle Ages, from about the A.D. 400's to the late 1400's, people ridiculed the handicapped and regarded them with suspicion. Some nobles used the physically disabled as court jesters. Many handicapped people were burned as witches.

Attitudes toward the handicapped began to change during the 1800's. Many people began to pity the disabled and treated them with special care. Nevertheless, individuals with handicaps were thought to bring shame

Rehabilitation of the handicapped includes therapy that helps them learn or regain various skills. The young man shown above is learning to walk with an artificial leg.



Special education helps handicapped children use their full learning ability. In the picture above, mentally retarded children are working with computerized learning devices.

on themselves and their families. As a result, most handicapped people were kept hidden away at home or in special institutions.

During the mid-1900's, important advances were made in the treatment of the handicapped. Until that time, many people who became paralysed below the waist died as a result of urinary problems. But in the 1940's, the discovery of certain antibiotics enabled doctors to keep these patients alive. Modern rehabilitation techniques were developed to help such victims lead full, productive lives. During World War II, and after the war ended in 1945, extensive efforts were made to rehabilitate disabled servicemen. Military hospitals established rehabilitation centres, and soon many other hospitals also set up these facilities. Many countries now make some provision for the education and employment of handicapped people.

Related articles in ***World Book*** include:

Famous handicapped people

Beethoven, Ludwig van
Braille, Louis
Brown, Christy
Browning, Elizabeth Barrett
Edison, Thomas A.
Goya, Francisco
Keller, Helen A.
Milton, John
Roosevelt, Franklin D.
Toulouse-Lautrec, Henri de

Speech therapy helps many handicapped people improve their ability to talk. An audio-therapy unit amplifies the voice of a therapist working with children who have a severe hearing loss.

Other related articles

Artificial limb
Audiology
Bell, Alexander Graham
Blindness
Braille
Cerebral palsy
Deafness
Dog, Guide
Ear (Disorders of the ear)
Eye (Diseases of the eye)
Hearing aid
Lip reading
Mental illness
Mental retardation
Multiple sclerosis
Occupational therapy
Physical therapy
Poliomyelitis
Psychiatry
Spastic paralysis
Special education
Speech therapy

Handicraft, also called *handcraft* or *craft,* refers to a particular skill or art of making objects by hand. Handicraft can mean the making of useful objects such as baskets, bowls, or rugs. It can also mean creating beautiful objects for decoration. These include jewellery, leaded glass windows, wall hangings, and wood carving. Some handicrafts have reached such a high degree of workmanship that they may be referred to as an art. For a clearer definition of the arts see **Fine arts** and its *Related articles.*

The earliest handcrafted objects may have been items that people cut from wood with sharpened stones. Prehistoric people had to rely on handicrafts to make the things they needed, because they had no machines. Handcrafting served as the only method of creating objects for thousands of years.

Vocational training prepares handicapped people for an occupation. The man shown above in the wheelchair is learning computer skills designed to help him find employment.

Handmade fabrics for quilts or wallhangings are made in India. Fabrics also include hand printed designs and batik work.

Umbrellas with handles of *rattan,* the stem of a palm tree, are made by hand in this Malaysian workshop.

The Industrial Revolution of the 1700's and early 1800's brought about great changes in the way objects were made. People using machines could make items much faster and cheaper than could individuals working by hand. The mass production of goods reduced the demand for homemade items and handicrafts became a hobby rather than a necessary activity.

After World War II (1939-1945), a new interest in handicrafts emerged. By the late 1950's, many people had become disenchanted with mass-produced goods. They disliked the sameness and lack of artistic design they saw in many mass-produced objects. In response to this dissatisfaction craftworkers in many countries, who still worked by hand, were able to find a wider market for their products.

Handmade Oriental rugs, with their traditional designs have always been popular in the West. The work of gold and silversmiths is one of the oldest crafts. Simpler crafts are also in demand: handmade fabrics and *batik work,* (a method of decorating fabric with dye), wicker work, woven baskets, wooden carvings from Africa, and paper work from Japanese craftsmen are to be found in craftshops around the world. Also on sale may be the works of local craftworkers such as picture framers, potters, and weavers.

As public interest increased, schools and colleges began to teach crafts. Educators came to recognize that creating a crafted object requires many of the same artistic skills and design knowledge as the fine arts.

Handicraft materials include wood, leather, cork, plas-

Batik is a popular way of dyeing cloth. A design is printed with wax which resists the dye. In this way colourful fabrics are produced.

Japanese paper work includes the painting and making of huge kites. Kite making has been popular for hundreds of years in Japan.

ter, metal, fabric, yarns, beads, reeds, and shells. Most handicrafts require the use of such tools as hammers, needles, sewing machines, weaving looms, glass cutters, knives, or scissors. Modern handicrafts, such as plastic sculpturing or model making, use industrial materials and techniques.

People create handicrafts for a number of reasons. Many people learn craft skills as a challenging and entertaining hobby. They may also enjoy expressing themselves artistically as they create objects. Other people get satisfaction from making the things they need in everyday life. Often craftworkers design and make original objects to exhibit and sell. Doctors sometimes recommend handicrafts as therapy for people with emotional problems or physical disabilities (see **Occupational therapy**).

Woodcarving is one of the world's oldest crafts. This craftworker is using a knife to carve decorative objects.

Weaving colourful fabrics is a popular handicraft throughout the world. This woman is weaving a place mat on a hand loom.

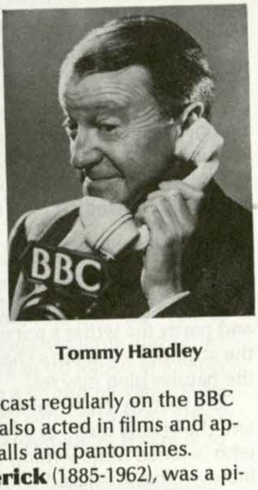
A potter uses the fingers to shape wet clay as it is spun around on a mechanical device called a *potter's wheel.*

See also the articles on *Handicraft hobbies* listed in the *Related articles* of the **Hobby** article.

Handkerchief is a small piece of cloth people carry to wipe their face, nose, or eyes. It is usually made of cotton or linen, but it may be of lace or silk. The people of ancient Greece and Rome used the first handkerchiefs we know about. During the Middle Ages (from the A.D. 400's to 1500), the handkerchief became a showy decoration. In France during the 1000's, wealthy men and women wore their handkerchiefs hanging from their belts.

As the use of the handkerchief spread, each nation developed its favourite materials. The French used silk and linen. The Italians used lace, and the English, silk or cotton. Today, some types are made only in certain countries. The best linen handkerchiefs are made in Ireland, Scotland, Belgium, France, and Switzerland. The best cotton handkerchiefs come from France and Italy, and the best silk handkerchiefs are made in China and Japan.

Handley, Tommy (1894-1949), was an English comedian who became famous during World War II for his weekly radio programme "ITMA (It's That Man Again)." This comedy programme ran from 1939 to 1949 and introduced many characters whose catch-phrases were repeated by many people. "Mrs. Mopp," with her "Can I do yer now, sir?", was especially popular. "ITMA" is considered by most critics to be one of the classic radio comedy shows. Handley was born in Liverpool and was named Thomas Reginald Handley. During World War I (1914-1918), he was a soldier and gained valuable acting experience by entertaining his comrades. Handley broadcast regularly on the BBC from 1926 until his death. He also acted in films and appeared in numerous music halls and pantomimes.

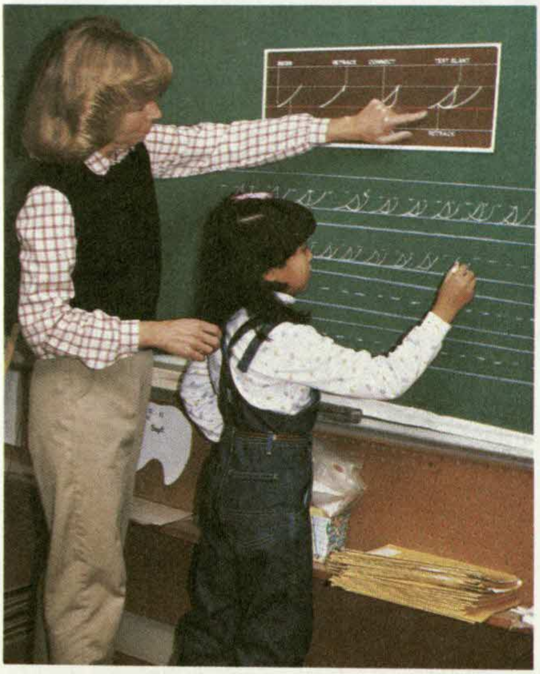


Tommy Handley

Handley Page, Sir Frederick (1885-1962), was a pioneer English aircraft designer and engineer. He was born in Cheltenham, Gloucestershire. In 1904, he founded Handley Page Ltd., a firm of aeronautical engineers, and was its chairman and managing director until his death.

Handley Page Ltd. specialized in manufacturing heavy aircraft. Its twin-engined 0/400 (1918) was one of the earliest heavy bombers. The Hampden and Halifax were widely used in World War II (1939-1945). The Victor, a turbo-jet strategic bomber, became operational in the RAF in 1958. Handley Page civil aircraft included the Hannibal, Hermes, and Herald transports.

Hands. See **Hand.**



Learning to write is one of the most important parts of education. This teacher is showing a student how to write correctly.

Handwriting is an important and immediate way of recording and communicating ideas. It is a product of the mind and the hand which combine to make on paper a portable, visual representation. Modern technology has given us many other methods of graphic communication, such as the word processor. But people will still use handwriting for many years to come, so it is worth understanding how it works and why it is important.

Handwriting reveals a lot about the writer. It is almost as individual as a fingerprint. It reflects partly what the writer may have been taught as a handwriting model, and partly the writer's personality. Some experts say that the stronger a person's character, the more individual the handwriting may be.

The written letters on the page are the direct result, and the visible trace, of a hand movement. A person who is tense while writing will therefore have tense handwriting. A relaxed writer will have relaxed writing. The writing of two such people will look different, even though they have been taught to write in exactly the same way. Handwriting also reflects emotion, how the writer feels at the time of writing. A person's handwriting may vary considerably. These variations are most obvious in *adolescence,* when a person is growing up, and developing in many ways. Handwriting also varies according to the writer's mood, or attitude to the task in hand.

The use of handwriting has changed considerably in recent years with the introduction of modern technology, such as word processors, into schools, colleges, and offices. Despite these advances, an efficient personal handwriting is still a vital skill, used in many different ways throughout life. A handwritten letter has a special meaning for friends and family. Even the handwritten address on the envelope will often bring to mind the writer. The handwriting, as well as the contents of a letter, may be either a relief or a worry to the reader. To an employer, a handwritten letter of application can reveal a lot about a prospective employee. To an informed medical practitioner, handwriting is a useful diagnostic tool.

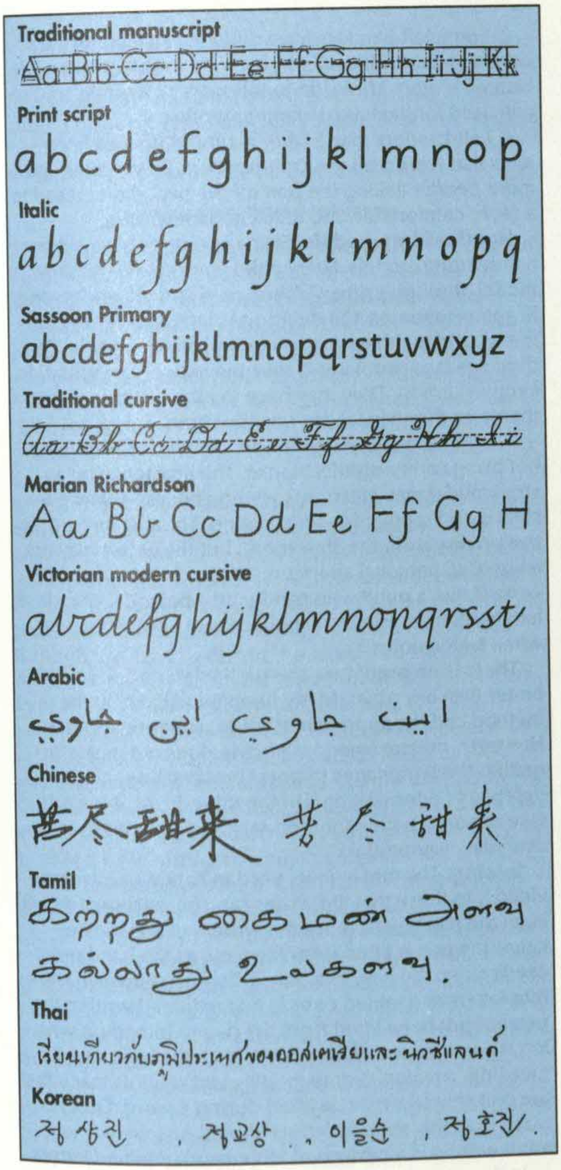
In the early years of school, almost all the work children do is handwritten. Teachers emphasize learning to write legibly and freely when recording ideas and copying. They may not put much emphasis on writing fast. In secondary school, college, and university, students may use handwriting most when notetaking and in examinations, where speed is as important as legibility. Typewriters or word processors are seldom suitable substitutes for the pen in these situations, even though their use is increasingly permitted for homework and essays.

Adults need to take notes, draft, and keep records in many occupations. Sometimes, such writing is solely for the use of the writer, but later it may need to be typed or printed. Whenever another person will have to read text or instructions, greater care must be taken with the standard and legibility of the handwriting. This usually means writing more slowly. Illegible instructions may have serious consequences. Meetings can be missed, letters may be lost because of badly written addresses, incorrect drugs may administered, or even the wrong surgical operations performed. Handwriting includes figures as well as letters. Badly written figures can easily be misread.

The signature is another important use of handwriting. The personal visible trace of the writer, and the equally personal but almost invisible pressure of the hand, together contribute to the security of the signature on cheques, wills, or other important documents. When using the signature to validate a transaction, consistency is more important than legibility. Many signatures bear little resemblance to the letters in the name.

Pen-lettering, or *calligraphy* (Greek for beautiful writing), is formal writing used as an art form. The *classical hands* (formal styles) that are taught today are based on the *book-hands* and *secretary hands* (used by clerks and secretaries), or ordinary handwriting models that were in use several centuries ago. Calligraphy can also be informal. Personal letterforms produced with a brush or felt-tipped calligraphic pen are becoming recognized as an art form. Calligraphy need not be confined to classical models. See **Calligraphy.**

Different kinds of handwriting. Written letters can be separated into categories such as separate letters and *cursive* (joined letters), or *upper-case* (capital) letters and *lower-case* (small) letters. They all have their special uses. There are different levels of handwriting. All writing must be *legible* (easy to read) because its purpose is to communicate. Today, when speed is often important, attitudes to writing need to be more flexible. Two or three different kinds of writing may be needed, to deal with different tasks. These might include a slow "special



Above are seven examples of English handwriting models: traditional manuscript or 'ball and stick', print script, italic, Sassoon primary, traditional cursive, Marion Richardson, and Victorian modern cursive. Below them are examples of handwriting in five other languages, showing different writing systems, and also personal differences between individuals.

occasions" hand, a faster hand for essays and examination papers, and an extra-fast writing for notes or lists.

An examiner needs to be able to read a paper, but students must not write too slowly in order to be extra-neat. Student will lose marks if they do not complete the work, because no marks can be given for words that are not there. Teachers and examiners may *scan* (glance quickly over) handwriting, and get information from the general context. This can help in deciphering a quick, personal handwriting. When writing an essay or examination paper in a foreign language, however, more importance may be given to accuracy. Therefore the student needs to ensure that the details of all letters are clear. People such as doctors and pharmacists write information vital to a reader and must be extra-careful about legibility.

On forms, it is often suggested that *block letters* (capital letters) should be used when filling in details. Capital letters are meant to be separated, and should therefore be easier to read. However people often try to speed up this rather slow way of writing, by joining up their capital letters. This defeats the whole purpose as joined capital letters look unfamiliar, and are difficult to read.

Learning to write

Handwriting is not a natural skill. It needs to be carefully and systematically taught. It is a *motor skill,* like playing a musical instrument, dancing, or gymnastics. In handwriting, the hand has to be trained in the intricate movements that produce each letter. Hand and eye must work together. To learn handwriting, children need to be ready to write, sufficiently developed to recognize and reproduce letters, and to have reached the stage where they want to communicate.

Early training is important. How to sit when writing and how to form letters are subjects best dealt with at the beginning of school life, before bad habits set in. Learning to write can be divided into two main parts. The first part concerns our writing system and the letters themselves. The second, equally important, part concerns the practical aspects of handwriting. This includes how to sit, place the paper, and hold the pencil in order to be relaxed and comfortable. Writers need to be able to move the writing arm freely, and must ensure that writing never becomes uncomfortable.

Our written alphabets evolved over many hundreds of years (see **Alphabet**). They are designed to fit in with the languages we speak, and the tools that we use. There are certain rules in any writing system. In English these rules are:

1. Writing goes from left to right, starting at the top of the page.
2. In each letter the line has to start in a certain place, and move in a specific direction. This may not seem to be an important rule when letters are large and separate, but eventually letters have to be joined in a recognizable, moving pattern. Once a wrong movement becomes a habit, it is increasingly difficult to alter. This is why the early training in the movement of letters is so vital.
3. Letters have different heights. These differences help to ensure that handwriting is easily legible.

Children need to learn the small letters first. There are other matters to explain to a learner, such as capital letters and spacing. These are more important than knowing the exact slant or proportion of letters. Good handwriting, of whatever style, is consistent. Models are useful in the early stages, but once children can write freely, with a good movement, strict training can be relaxed. Then individuals can start to develop, within the bounds of legibility, the personal letters and shortcuts that lead to a mature, efficient handwriting.

Handwriting technique. For good handwriting, posture is important. The way the writer sits, holds the pen, and places the paper makes a lot of difference to the actual written letters. The chair and desk or table must be the right height. A slanting surface is often better than a flat one. The position of the paper is important in encouraging a good writing posture. Enough space should be provided for children to experiment and find what works best for them. The paper is usually best placed to the side of the hand that is being used. This allows writers to see what they are writing. Right-handers put the paper to their right side, left-handers to their left. The paper can then be slanted slightly if desired.

Pencils and pens. What is comfortable for one hand, or suits one type of writing, may be quite wrong for another. There are many kinds of pencils; fat, thin, round, triangular, or hexagonal. Pencil leads vary in softness and thickness. Young children need a variety of pencils. Older pupils should be encouraged to experiment with different types of pens.

There are many kinds of writing implements available, so there are no easy rules about holding a pen. The traditional *tripod penhold* (first two fingers and thumb) worked well with pencils and fountain pens. Modern pens, however, work best at a more upright angle, and an alternative penhold that allows ballpoints and fibre-tipped pens to be held almost upright can help those who have a great deal of writing to do. Students who experience discomfort in examinations, for instance, sometimes place the pen between the index and middle finger, before arranging their fingers as they wish on the handle of the pen. The benefits of this penhold were researched by the Belgian neurologist Callewaert from 1940 to 1960, and it is sometimes known as "Callewaert's penhold".

Writing masters of the past, such as Gerardus Mercator (1512-1594), recognized the relationship between implement, penhold, and resulting letterforms. When one element altered, so did the other. In the modern world, great changes in writing implements have been made without considering the consequences for handwriting.

Left-handers may have problems writing an alphabet which seems to have been designed to suit right-handers. People who are naturally left-handed should not be made to change writing hands. A few tips can make life easier for them. A left-handed child may benefit from:

1. A slightly higher chair.

2. A soft-leaded pencil that will not dig into the paper and, later on, a modern pen that does not smudge.

3. Space on the desk to place the paper to the left side, and help in finding a paper position to suit both hand and eye.

4. Advice on penhold—such as not holding it too close to the point. These practical hints help left-handed writers to see what they have written, and to write more comfortably from left to right.

When writing letters, left-handers may need some specific help such as:

1. Guidance in the early stages in the left-to-right directions of writing and scanning, and in the movement of individual letters.

2. Some left-handers have difficulty making forward-slanting letters. This only becomes a problem when left-handed writers are made to follow such a model, or are criticized for backward-slanting writing.

3. Left-handers may find difficulty with some letter-joins that work well for right-handers. Fewer joins and more *penlifts* (taking the pen off the paper) often lead to a more comfortable and efficient handwriting.

Handwriting models. Some countries have national handwriting models. Every child learns from the same model, through primary school and sometimes beyond. In some countries, the decision is left to local governments, and in others it is left to individual schools. Children can face problems if they move to a new school in another district. They may have to alter the model, and therefore the style, of their handwriting. This is not easy.

A national handwriting model avoids this problem, but brings other disadvantages. The insistence on a strict model may mean that young children achieve a similar and regular-looking writing. This can look attractive on display in the classroom, but the writer may not learn vital, personal shortcuts. When children need to write faster, a pupil who produced a beautiful, standard handwriting in primary school cannot always keep up when taking notes.

There is no proof that one particular model works better than any other. Many people believe that the method and the approach of the teacher are important. However, greater freedom of style does not mean forgetting the advantages of good presentation, nor is it a defence of poor writing. On the other hand, it is a mistake to confuse the more formal art of calligraphy with everyday handwriting.

Joining. The movements used in handwriting are divided into those that the writer can see, because the pen is on the paper, and those the writer cannot see because the pen is lifted from the page as the hand proceeds along the line. The only difference between separate letters and joined ones is that in joined writing the pen has not been lifted from the paper. Joined-up writing is sometimes called *cursive,* from the Latin word meaning "running". Some models and schools teach that the pen should never be lifted during a word. Others teach that only specific letters should be joined. Most adult writing is a mixture of joined and unjoined letters.

In the past, people wrote with *quills* (pens made from feathers), or pointed metal pens. If the writer stopped in the middle of a word, the pen "spluttered", and made an inky mess, so continous, cursive writing was necessary. Today we use modern pens, and hold them in a different way. Our fingers may need a rest in mid-word, or we may need to move the hand along the line. Handwriting teachers usually suggest that writers lift the pen whenever they wish. A large, round writing may require more penlifts than a small oval one.

Some joins help to speed handwriting, because less time is spent lifting and repositioning the pen. Some joins make handwriting look more mature and interesting. However, badly joined handwriting can be more difficult to read, and less efficient to write.

When learning to join letters, handwriting students are often criticized for untidy handwriting, so they revert to separate letters. They may then become discouraged from developing a mature writing. Others feel that when they stop in the middle of a word for any reason, they should disguise the penlift with a false backward joining stroke. Joining requires practice and it is worth persevering to find a level to suit individual needs.

Handwriting problems

Problems usually arise when children have been inadequately or inappropriately taught, or when there is some physical problem. Because hand and eye are involved in the act of writing, any visual or coordination problem is likely to show in writing. Bad writing can also be caused when other problems influence the letters. Spelling difficulties, tension, or unhappiness can all disrupt the flow of writing. Poor handwriting indicates a problem, and the challenge for the teacher is to find the cause and solve it.

If the basic movement of any letter is incorrect, it is worthwhile altering it. Even this seemingly simple change is not easy. It is often better to approach handwriting from the physical angle, and consider whether the way the writer holds the pen is affecting the written trace, or whether severe tension is being transmitted through the hand to distort the letters. To alter the movement of any particular letter, the writer must learn to move the hand in a different direction.

The hand and the letters are closely connected. Altering one alters the other. Such characteristics as the slant and proportion of letters depend on how a writer holds the pen or positions the hand. Knowing this, writers can experiment, relax, and solve their own problems. Trying to alter a handwriting by copying a quite different model seldom improves it. Most handwriting teachers believe it is better to improve within the writer's own personal style of writing, by finding a better technique.

Practical help and praise are more likely to contribute to handwriting improvement than criticism. Uninformed criticism is likely to be counter-productive. Critical comments such as "badly written" can refer to a badly laid out page, excessive erasures because of spelling mistakes, or genuinely illegible letters. Moreover, the judgment of what is legible or acceptable is often subjective, influenced by the reader's expectation, experience, or personal preference for a particular style.

History

The first writing systems were invented when people felt the need to keep permanent records. The rise and fall of ancient civilizations can be traced through their handwriting. Civilizations without a writing system to record their history may have vanished without trace. Writing systems evolved separately within different civilizations, and were influenced by the natural materials found in different regions. *Cuneiform* writing evolved in Sumer about 3000 B.C. (see **Cuneiform**). Wedge shapes were inscribed with a reed stylus in clay tablets. Originally a form of picture-writing, cuneiform evolved into a syllabic system. At about the same time, *hieroglyphics* were evolving in Egypt (see **Hieroglyphics**). These signs were written on papyrus, using reed pens, or were inscribed on blocks of stone. In the Far East, writing appeared in China, where an *ideographic* (symbolic) form of characters developed that is still in use today. People of the Indus Valley civilization used *pictograms.* Pictograms are pictorial representations of objects. For example, a picture of the sun means *the sun. Ideograms* are more symbolic: a picture of the sun represents *light.* Both systems are useful because they can be understood in any language. They survive today in universally recognizable road signs.

As civilizations and writing spread westward around the Mediterranean, our present alphabet developed from the early Roman and Greek capital and cursive alphabets. These alphabets in turn had evolved from the Phoenician and older Semitic writing systems of the Middle East. The first alphabet was probably invented before 1700 B.C. We do not know who invented it or how this was done. See **Alphabet.**

In the early Christian era, monks produced religious manuscripts and books, often beautifully illuminated and gilded. Few ordinary people could write, and professional writers called *scribes* were employed to produce legal and other essential documents.

Mechanical printing was invented in China. Where the technique spread to Europe in the 1400's, books could be made more speedily. This helped the spread of learning, and the development of a school system. Language and spelling became more standardized. As writing became the sign of a good education, writing masters were employed in large households to educate the family. Throughout the law courts, governments, and the new universities of Europe, extensive written work led to other nonreligious uses for writing. Different forms of handwriting for different purposes came into use, and these varied from country to country.

By the beginning of the 1800's, elementary schools were educating much of the population in Europe. Many of these people were employed as clerks. All over the world, the use of handwriting again changed. It remained an essential part of the commercial and industrial world until the invention of the typewriter in the late 1800's took away a lot of the drudgery of the clerk's work. Today, the computer and other modern technology can relieve the strain of producing fast, clear, consistent writing. The use, and perhaps the quality, of personal handwriting may alter once more.

Handwriting has developed with the change in writting implements. The broad-edged quill gave way first to the pointed quill, then to the pointed metal nib, the fountain pen, and eventually to modern ballpoint and fibre-tipped pens. Each change brought new letterforms, and also new ways of holding a pen. Handwriting is again at an exciting stage in its evolution, as people develop new handwriting forms to fit the needs and the writing implements of the future.

Related articles in ***World Book*** include:

Alphabet
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Chinese language (picture)
Communication
Cuneiform
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Hieroglyphics
Japanese language (picture)
Language
Letter writing
Manuscript
Palaeography
Pen
Pencil
Pictograph
Punctuation
Reading
Shorthand
Speedwriting
Spelling
Writing

Handwriting on the wall, also known as the writing on the wall. According to a Bible story (Dan. 5:1-31), the Babylonian ruler Belshazzar, saw the fingers of a man's hand writing the Aramaic words *mene, mene, tekel, upharsin* on his palace wall. Daniel, the Hebrew prophet, said they meant that God had weighed Belshazzar and his kingdom and had found them wanting, and would destroy them. The phrase *handwriting on the wall* now means impending disaster or misfortune.

Handy, W. C. (1873-1958), was an American composer of blues songs. Handy did not invent the *blues,* which is a form of folk music. But he became known as the father of the blues because he brought the music to widespread public attention.

Handy wrote some of the earliest commercially successful blues songs, including "Memphis Blues" (1913), "St. Louis Blues" (1914), "Joe Turner Blues" (1915), and "Beale Street Blues" (1916).

W. C. Handy

William Christopher Handy was born in Florence, Alabama, U.S.A., and moved to Memphis, Tennessee, about 1908. He formed his own band, which toured the South for many years. In the early 1920's, Handy moved to New York City and started his own music publishing company. In 1943, he was blinded in an accident, but continued his work as a publisher, author, and concert promoter. He wrote an autobiography, *Father of the Blues* (1941), and a book on black American musicians, *Unsung Americans Sung* (1944).

Hang-chou. See Hangzhou.

Hang gliding. See Glider (Hang gliding).

Hang Tuah (1450?-1500?) is the most famous Malay folk hero. According to legend, he displayed traditional Malay ideals of bravery, skill, and cunning as a warrior, and unswerving loyalty to his ruler. The most believable stories about Hang Tuah occur in *Sejarah Melaya* (Malay Annals), which were compiled in about 1520. The work describes him as a young man who serves the sultan of Melaka in the late 1400's. After various adventures against dangerous opponents, he finally becomes admiral of Melaka.

The fullest account of Hang Tuah's exploits can be found in *Hikayat Hang Tuah* (Romance of Hang Tuah), a Malay work probably compiled in the mid-1600's. These stories portray him as a perfect hero protected by supernatural elements, including a dagger that keeps him from all harm. In modern times, Hang Tuah has become the heroic subject of many stories and films.

Hanging is a means of execution. The condemned person stands on a platform with a noose of rope around his or her neck. A trap door opens under the person, and the person falls until jerked to a stop by the rope. The sudden jolt breaks or dislocates the bones of the neck, causing almost immediate loss of consciousness.

In Britain, Ireland, and New Zealand, for example, hanging is still a legal method of execution for treason and piracy. In countries such as Malaysia, and some states of the United States, drug related offences are punishable by hanging.

Hanging Gardens of Babylon. See **Seven Wonders of the Ancient World.**

Hanging valley is a valley whose mouth lies high on the side of a larger valley. Hanging valleys typically occur in mountainous areas, where small, tributary glaciers once flowed into larger glaciers. Because of its greater weight, the larger glacier carved out a deeper trough than the smaller glacier did. This accounts for the difference in the levels of the two valley floors. After the ice melted, a hanging valley remained above the main valley's rim. A stream in a hanging valley may form a waterfall as it tumbles into the valley below.

Hangzhou (pop. 1,191,582) is a Chinese tourist centre and the capital of Zhejiang Province. The city's name is also spelled *Hang-chou* or *Hangchow.* The city lies on a bay about 160 kilometres southwest of Shanghai. For location, see **China** (political map). Industries in the area produce chemical and electronics products, iron and steel, and silk. Many tourists visit Hangzhou's famous Xi (West) Lake. Along the shore, and on four islands in the lake, are many gardens, statues, and temples.

Hangzhou began as a small fishing village. During the A.D. 500's, it became a trading centre and grew rapidly. In the 1100's, the Song emperors made Hangzhou their capital. By the 1200's, Hangzhou had become one of the largest cities in the world. The city was badly damaged during the Taiping Rebellion (1850-1864), but was later rebuilt. The Japanese occupied Hangzhou from 1937 until the end of World War II in 1945. Most of Hangzhou's industries were developed after the Chinese Communists took over the country in 1949.

Hankou. See **Wuhan.**

Hannan, Paddy (1843-1925), discovered some gold nuggets 80 kilometres northeast of Coolgardie, Australia, in 1893. The new goldfield became the site of Kalgoorlie. Patrick Hannan was born in Quin, County Clare, Ireland. He emigrated to Melbourne in 1863.

Hannibal (247-183 B.C.) was the greatest general and statesman of Carthage, an ancient North African city. His excellent military strategy and leadership ability helped him overcome great handicaps and defeat armies much larger than his own. He united people of varied backgrounds under his command. Even under poor conditions, his army followed him with confidence.

His early life. Hannibal was born in Carthage. His father, Hamilcar Barca, was also a military leader. Hamilcar Barca hated the Romans, his city's chief enemy. According to tradition, Hamilcar made young Hannibal take an oath always to be an enemy of Rome. As a boy, Hannibal went with his father to Spain, a land partly ruled by Carthage. As a young man, Hannibal led troops against Spanish tribes, and helped increase Carthaginian power in Spain. Hannibal became the Carthaginian commander in Spain when he was 25 years old.

In the 220's B.C., trouble developed between Carthage and Rome over Hannibal's expansion. Hannibal attacked Saguntum, a Spanish ally of Rome, in 219 B.C. Rome de-

Detail of a Flemish tapestry; Palazzo del Quirinale, Rome

Hannibal fought the Romans in the Second Punic War. This scene shows the Roman general Scipio, *left,* meeting Hannibal, *right,* in an effort to negotiate peace. Scipio's forces defeated Hannibal at Zama in northern Africa in 202 B.C.

clared war on Carthage—the Second Punic War—in 218 B.C.

His military campaigns. Early in the war, Hannibal astonished the Romans with a daring manoeuvre. Starting from Spain with about 60,000 troops, he crossed the Pyrenees, France, and the Alps, and entered Roman Italy. Snow and cold, and fierce mountain tribes killed many Carthaginians in the Alps. Hannibal reached the Po Valley in northern Italy with only about 26,000 troops and 6,000 horses. He also brought a few elephants because they could sometimes shatter enemy lines, like tanks in modern battles. He then recruited 15,000 to 20,000 Gauls into his army. The Gauls, also called Celts, from the Po Valley, were enemies of Rome.

A Roman army brought up from Sicily tried to stop Hannibal's advance. But Hannibal manoeuvred the Romans into an ambush and defeated them in the Battle of Trebia River. Hannibal moved on to central Italy in 217 B.C. There, he tricked a Roman army into following his army, and then destroyed the Romans in an ambush on the shores of Lake Trasimeno.

In 216 B.C., Hannibal found himself far outnumbered by the Romans at Cannae, in southern Italy. Hannibal arranged his troops in an arc. When the Romans attacked, the centre of the formation retreated, and the two sides, with the help of Hannibal's superior cavalry, encircled and crushed the Romans. The Carthaginians killed about 50,000 enemy troops in one day in the worst defeat ever suffered by a Roman army.

The turning point. After Cannae, Hannibal's future looked good. But the tide soon turned against him and Carthage. Hannibal had gained allies in southern Italy, Macedonia, and Syracuse, Sicily. But some of his allies became too busy with their own affairs to help him. The Romans still had allies and many troops of their own in central Italy, and were able to prevent reinforcements from reaching Hannibal. Meanwhile, the Roman general Publius Cornelius Scipio drove the Carthaginians out of Spain, and in 204 B.C. invaded Africa. Hannibal was called home to Africa in 203 B.C. He was finally defeated by Scipio at Zama, in northern Africa, in 202 B.C. The war ended in 201 B.C. with Rome the winner in spite of Hannibal's great effort.

After the war. Rome allowed Carthage to govern itself. Hannibal headed the government, and Carthage made a rapid recovery under his leadership. But he fled eastward in 195 B.C., after he heard that the Romans were going to demand his surrender. He found protection with King Antiochus III of Syria, who was about to go to war with Rome. Antiochus made little use of Hannibal's genius and lost the war in 189 B.C. Hannibal then fled to Bithynia, an ancient country in what is now Turkey. When the Romans demanded his surrender, Hannibal committed suicide.

See also **Carthage; Hamilcar Barca; Punic Wars.**

Hannover. See **Hanover.**

Hanoi (pop. 3,058,855), is the capital and second largest city of Vietnam. Only Ho Chi Minh City has more people. Hanoi lies at the head of the fertile Red River delta. For location, see **Vietnam** (map).

Hanoi served as the capital of Vietnam from the 1000's until 1802, when Hue became the capital. After an international agreement divided Vietnam in 1954, Hanoi became the capital of Communist North Vietnam. In the mid-1960's—during the Vietnam War—Hanoi relocated much industry to the countryside to escape bombing by the United States. The bombing damaged industrial suburbs but left the city almost untouched. North Vietnam took control of South Vietnam in 1975 at the end of the war. It unified North and South Vietnam into the single nation of Vietnam. Hanoi became the capital of the unified nation.

Hanoi is an important commercial centre and river port. Haiphong, located about 89 kilometres from Hanoi near the Gulf of Tonkin, serves as a deepwater port for Hanoi. Hanoi's most important industry is food processing. The city also produces bicycles, cigarettes, and farm machinery.

Administrative offices, shops, and houses line many of the broad streets of Hanoi. Bicycles, trams, and trucks crowd the streets. Government officials drive the only cars. The University of Hanoi is the main centre of higher learning in northern Vietnam.

Hanover, also spelled *Hannover,* is a historic area in what is now northern Germany. In 1692, Hanover became an *electorate,* a territory whose ruler—called the *elector*—could help elect the emperor of the Holy Roman Empire. In 1714, the Elector of Hanover became King George I of England. Hanover and England remained associated until 1837, when George's last male heir died. Prussia gained control of Hanover in 1866, and Hanover became a province of the new German Empire in 1871. In 1946, Hanover became part of the West Germany state of Lower Saxony.

The Hanover region includes the cities of Göttingen, Emden, Hanover, and Oldenburg. Farming is Hanover's chief industry. But the region is also a manufacturing centre. The Harz Mountains area yields timber and minerals.

Hanover (pop. 508,298), also spelled *Hannover,* is one of the largest cities in Germany. For location, see **Germany** (political map). The city is the capital of the state of Lower Saxony. Hanover was chartered in 1241. It served as the capital of the Kingdom of Hanover from 1815 to 1866.

Hanover is a manufacturing centre. Its products include office equipment, machinery, vehicles, rubber goods, tobacco products, chocolate, and biscuits. The city holds an industrial fair each year. Hanover is also a railway centre, and the Mittelland Canal flows through the area.

Hanover was heavily bombed during World War II, but it was rebuilt. It has a number of historical buildings. The buildings include Market Church, a Gothic church built in the 1300's; and the Old Town Hall, which dates from the 1400's. The city also has magnificent formal gardens called the *Herrenhausen Gardens.* The gardens date from the 1600's.

Hansard is the name of the official reports of the proceedings of the British Parliament. Hansard contains *verbatim* (word for word) texts of the proceedings of both the House of Commons and the House of Lords. Her Majesty's Stationery Office (HMSO) publishes the reports daily when Parliament is in session and also issues weekly and periodic collections of reports. The full title is *Parliamentary Debates (Hansard).*

In 1803, William Cobbett began publishing edited reports of parliamentary debates. In 1811, he sold his rights to his printer, Thomas Curson Hansard, and the reports continued under the title *Hansard's Parliamentary Debates* until 1892. Various other firms published the reports until 1909, when HMSO began publishing them.

Hanseatic League was a confederation of north German cities, founded in the late 1200's. The decline of the imperial power in Germany made it necessary for these cities to band together for common protection of their interests. The Hanseatic League, or *Hansa,* seems to have resulted from two earlier confederations which were grouped around the cities of Cologne and Lübeck. By the middle 1300's, the members of the Hansa included almost all the larger German towns along the North and Baltic seas.

The League had no formal constitution. Its only governing body was a congress made up of merchants from the various cities. The main weapons of the League were commercial boycott and commercial monopoly (see **Boycott; Monopoly and competition**). If a town refused to join the League, its merchants would be unable to sell their goods in profitable markets. One of the greatest contributions of the Hanseatic League was the system of maritime and commercial laws that it developed.

The Hanseatic League gained control of the fur trade with Russia, the fish trade with Norway and Sweden, and the wool trade with Flanders. In 1370, the Danish king tried to break the League's power by closing the Sound. A Hanseatic fleet seized Copenhagen and im-

Hanover's city hall is located on beautifully landscaped grounds. Hanover lies about 97 kilometres southeast of Bremen. It was once the capital of the Kingdom of Hanover. It is now a major trading and manufacturing city.

posed severe peace terms on Denmark. The Hanseatic League had passed out of existence by the end of the Middle Ages.

See also Flag (picture: Historical flags).

Hansen's disease. See **Leprosy.**

Hanukkah is the Jewish Festival of Lights or Feast of Dedication. The Hebrew word *hanukkah* (also written *Hannukah* or *Chanukah*) means *dedication.* The Hanukkah holiday begins on the eve of the 25th day of the Hebrew month of Kislev (approximately December) and lasts eight days.

Children light candles in a menorah during Hanukkah.

During Hanukkah, gifts are exchanged and contributions made to the poor. Each evening, one candle is lit in a special eight-branched candelabrum called a *menorah* or *hanukkiyah.* Beginning on the second night, one candle is added every night until the total reaches eight on the last night. The candles are lit by a separate candle called a *shamash.*

The two books of Maccabees in the Apocrypha tell the story of Hanukkah. In 165 B.C., after a three-year struggle led by Judah Maccabee, the Jews in Judea defeated the Syrian tyrant Antiochus IV. They held festivities in the Temple in Jerusalem, and dedicated it to God. According to the Talmud, written many centuries after the event, when the Jews cleaned the Temple of Syrian idols, they found only one small cruse of oil with which to light their holy lamps. But miraculously, the cruse provided them with oil for eight days. Other sources tell of a torchlight parade in the Temple, which may also have contributed to the tradition of lighting candles on Hanukkah.

Hanuman is the monkey general in the Indian epic poem, the *Ramayana.* In this poem, Hanuman is the general who commands the monkey army fighting for the hero, Rama. See **Ramayana.**

In Indonesia, Hanuman is a favourite figure in the *wayang kulit* (shadow theatre). In the Malay-language version of the story, Rama and his wife Sita Dewi are turned into monkeys after bathing in a forbidden pool. They later turn back into humans. But when their son, Hanuman, is born, he turns out to be a monkey.

Hanuman seems to have caught the imagination of people in Indonesia. He is depicted in Indonesian dances, paintings, dramas, and sculptures. In Bali, the *kecak* dance, with its monkey chorus, portrays Hanuman's journey to Lanka (Sri Lanka) and his adventures there.

Hanyang. See **Wuhan.**

Hapsburg, House of. See **Habsburg, House of.**

Hara-kiri is a method of suicide used by members of the Japanese warrior class, or *samurai.* In hara-kiri, the warrior cuts a gash in his abdomen according to a prescribed manner. An assistant then cuts off the warrior's head from behind. The Japanese term this ceremonial rite *seppuku.*

During the feudal period in Japan, the samurai considered it a duty to sacrifice themselves through hara-kiri, rather than to submit to public disgrace (see **Samurai**). They performed the act as an ultimate gesture of loyalty to the lord or to a noble cause. Later, defeated commanders sometimes committed hara-kiri. Today, the custom is generally discredited.

Harald. See **Harold.**

Harappa. See **Indus Valley civilization.**

Harare (pop. 656,100) is the capital and largest city of Zimbabwe. The city serves as Zimbabwe's centre of government, banking, and commerce. For location, see **Zimbabwe** (map).

In the centre, modern hotels and office buildings rise along wide, busy streets. Africa Unity Square, an open area with a beautiful park, is there. The Harare area includes an art museum, the University of Zimbabwe, and an international airport. Both wealthy suburbs and crowded slums lie on the outskirts of Harare.

Harare is a trading centre for products raised on the region's fertile plains. The chief products are citrus fruits, maize, cotton, and tobacco. Industries in Harare produce clothing, fertilizers, furniture, and steel.

White South African settlers founded Harare in 1890. The town was first called Salisbury, a British name. It was governed by a British company organized by the diamond king Cecil Rhodes. In 1923, Great Britain made Salisbury the capital of the self-governing colony of Southern Rhodesia. The colony became the independent nation of Zimbabwe in 1980. In 1982, Salisbury was renamed Harare, an African name.

See also **Zimbabwe** (picture).

Harbin (pop. 2,590,000) is one of the large cities of China. It is the capital city of Heilongjiang, the northernmost province in the region of Manchuria. For location, see **China** (political map).

Harbin serves as an important railway centre. The east-west and north-south lines of the Manchurian railways intersect there. Chinese rail lines extend from Harbin to the Russian border in the northwest and east, and to Lüshun-Lüda and the Korean border in the south. Harbin's location on the Sungari River makes it an important port. The fertile soil in the area produces maize, soybeans, and wheat. Harbin's chief exports are soybean products and flour. Manufactured products include agricultural implements, chemicals, and leather.

Russia established Harbin in 1895 as a railway administration centre. After Japan defeated Russia in the

Russo-Japanese War (1904-1905), China and Japan controlled Harbin jointly. Japan governed Harbin from 1932 until 1945, when China gained control. In the 1960's, the Chinese, fearing an attack by the Soviet Union, built many underground factories and stores in Harbin. Harbin has many Russian-style buildings that date from the time when Russia controlled the city.

Harborough (pop. 66,200) is an extensive rural local government district in Leicestershire, England. Market Harborough is a market town dating from the reign of Henry II. Its market, to which farmers still bring their cattle and sheep, was first mentioned in 1204. Lutterworth dates from Saxon times. John Wycliffe became rector of Lutterworth in 1374 and there completed the first English translation of the Latin Bible. Harborough district's industries include agriculture, boatbuilding, brewing, engineering, printing, and making clothing and knitwear, food, and furniture.

Harbour is any sheltered body of water where ships may moor or anchor. Natural or landlocked harbours are found in bays and inlets where arms of land form a natural protection from waves and winds. Artificial harbours are made by erecting *breakwaters* made of stone or steel.

A commercial harbour should be at least 11 metres deep, so the keels of large ships will not touch the bottom. Ships should also have enough room to pass and to turn around. The bottom of the harbour should not be too rocky, too sandy, or too muddy, or anchors will not be able to hold ships securely.

Large harbours are lined with quays, piers, and docks at which ships can be loaded and unloaded. A *quay* (wharf) is a stone or wooden platform built along the shoreline, a *pier* is a platform which extends well out into the water, and a *dock* is the space between piers.

Some of the most beautiful harbours are at Rio de Janeiro; Naples, Italy; and San Francisco, U.S.A. The world's busiest harbours include those at Kharg Island, Iran; Kobe, Japan; New York City; Ras Tanura, Saudi Arabia; and Rotterdam, the Netherlands.

Related articles in *World Book* include:

Pictures of harbours

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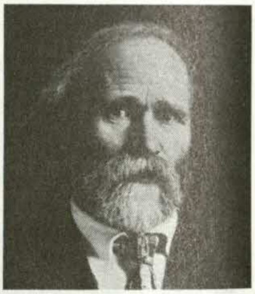
San Diego
Ship
Singapore
Sydney

Other related articles

Breakwater
Buoy
Dock
Dredging
Pier
Port

Hardening of the arteries. See Arteriosclerosis.

Hardie, Keir (1856-1915), was a pioneer of the British Labour Party. He entered Parliament in 1892 as member for West Ham, South. He was largely responsible for the founding of the Independent Labour Party and was its first chairman. In 1900, he helped to found the Labour Party, then known as the Labour Representation Committee. He strove to spread trade unionism, and followed a pacifist policy, strongly opposing the Anglo-Boer War. He also supported women's *suffrage* (right to vote). James Keir Hardie was born near Holytown, in Strathclyde Region, Scotland.



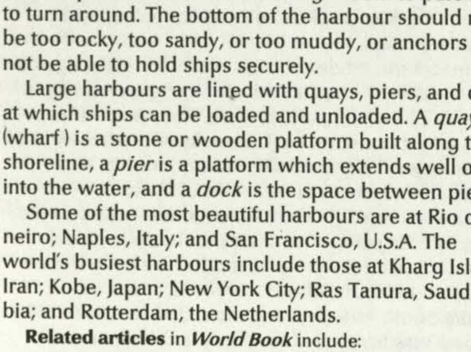
Keir Hardie

Harding, Warren Gamaliel (1865-1923), was president of the United States from 1921 until his death on Aug. 2, 1923. Historians almost unanimously rank Harding, a Republican, as one of the weakest U.S. presidents. His administration was plagued by a number of scandals. The most shocking case was the Teapot Dome Scandal. It involved Secretary of the Interior Albert B. Fall, who accepted a bribe (see **Teapot Dome**).

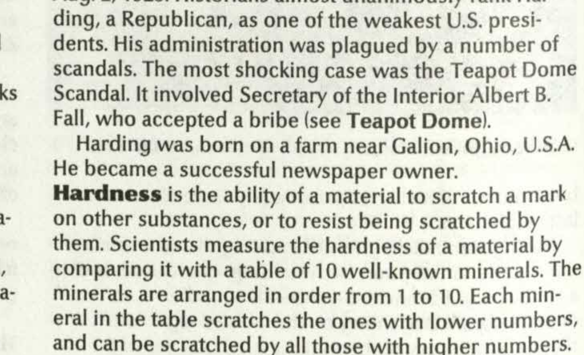
Harding was born on a farm near Galion, Ohio, U.S.A. He became a successful newspaper owner.

Hardness is the ability of a material to scratch a mark on other substances, or to resist being scratched by them. Scientists measure the hardness of a material by comparing it with a table of 10 well-known minerals. The minerals are arranged in order from 1 to 10. Each mineral in the table scratches the ones with lower numbers, and can be scratched by all those with higher numbers. The standard "scale of hardness" follows:

1. Talc
2. Gypsum
3. Calcite
4. Fluorite
5. Apatite
6. Feldspar
7. Quartz
8. Topaz
9. Corundum
10. Diamond



Artificial harbours, such as Belmont Harbor in Chicago, *above,* have been built along Lake Michigan.



Natural harbours, such as the one in Sydney, Australia, *above,* are the sites of some of the most important cities in the world.

To test another substance, you match it against the minerals of the hardness scale. You can get an approximate idea of the hardness of a mineral by using your fingernail, a copper coin, a knife blade, or a piece of glass. The hardness of these materials is as follows: fingernail, about 2; copper coin, 2½ to 3; knife blade and glass, 5½.

When materials must be accurately tested, as in the manufacture of tools and gears, machinists use an instrument called a *sclerometer*. This device registers the force required to dent or scratch the material with a piece of diamond or borazon, the hardest substances known.

See also **Diamond; Borazon.**

Hardtack. See **Scurvy.**

Hardwood. See **Timber** (Kinds of timber); **Tree** (Broadleaf trees; Broadleaf forests; picture); **Wood.**

Hardy, Frank (1917-), an Australian author, became known for the social themes that characterized such books as *The Unlucky Australians.* His first novel, *Power Without Glory* (1950), was followed by a charge of criminal libel, of which he was subsequently acquitted. He later published five more novels, including *But the Dead Are Many,* published in 1975. The novel received praise from critics in Australia and England. Many critics consider his best writing to be his six collections of short stories. He also published three collections of humorous stories featuring the characters Billy Borker and Truthful Jones, as well as a book of cricket stories with the English cricketer Freddie Trueman, called *You Nearly Had Him That Time.* Francis Joseph Hardy was born near Warrnambool in Victoria.

Hardy, Oliver. See **Laurel and Hardy.**

Hardy, Thomas (1840-1928), was an English novelist and poet. Fate is the "villain" in most of Hardy's books, and his characters fight a losing battle against this impersonal force. Hardy summed up his anger at the unfairness of life in the novel *Tess of the d'Urbervilles.* He wrote that, with the heroine's death, "'Justice' was done, and the President of the Immortals, . . . had ended his sport with Tess."

Recent criticism has tended to view Hardy's characters as people with psychological weaknesses. But it seems fair to say that Hardy saw human downfall not primarily as personal weakness, but rather as the result of an unwilling conflict with a hostile, meaningless universe.

Most of Hardy's stories take place in the fictional county of Wessex, a place of gloomy landscapes well suited to stories of tragedy. Hardy modelled Wessex on the county of Dorset, his birthplace.

Hardy's first successful novel, *Far from the Madding Crowd* (1874), contrasts selfish love with selfless love. *The Return of the Native* (1878) is a sombre story of the tragic results of a man's illicit love for a woman. *The Mayor of Casterbridge* (1886) traces the spiritual and physical deterioration of a respected man. Hardy's last great novels, *Tess of the d'Urbervilles* (1891) and *Jude the Obscure* (1895), treat the theme of sexual attraction with a frankness that shocked the people of his time. The public outcry against *Jude the Obscure* was so great that Hardy stopped writing novels and turned to poetry.

He wrote lyric poetry of high quality, but he is best known for a three-part epic drama in verse, *The Dynasts* (1903-1908). The poem centres on Napoleon. Hardy used abstract figures to symbolize "Immanent Will," the blind force that he felt moves the world.

Hardy was born in Upper Bockhampton in Dorset. He studied architecture and worked as an architect. In the early 1870's, he abandoned architecture for a full-time career as a writer.

Hare is a long-eared mammal with powerful hind legs and a short, fluffy tail. Hares are related to rabbits and are often confused with them. But hares differ from rabbits in several ways. Hares give birth on the ground or in a scratched-out depression called a *form.* The young are born covered with fur and with their eyes open. Rabbits are born naked and blind in a fur-lined nest. Hares never dig burrows as do many rabbits. Also, hares usually try to escape from their enemies by leaping away rapidly. Rabbits usually try to hide from enemies. The *Belgian hare* is really a type of rabbit. The North American *snowshoe rabbit* and the *jack rabbit* are, in fact, hares.

Most hares are brownish-grey with a pure white belly. Some kinds of hares that live in cold climates turn completely white during the winter. The largest hares grow to nearly 70 centimetres long and can reach a weight of more than 3.5 kilograms.

Hares court and mate in spring. During courtship, they often jump and twist in the air. This behaviour may explain the phrase "mad as a March hare." Young hares are called *leverets.* There are usually fewer than five in a litter, but there may be as many as seven litters a year.

Hares rest during the day and generally look for food during the night and at dawn. Hares eat plants and can

Hares have long ears, long forelegs, and an upward stance. They generally live in open country or the edge of woods. Their young are born in a shallow hollow in the ground.

become pests by eating and destroying alfalfa and other farm crops. Hares *thump* (tap the ground) with their hind legs, which may warn other hares of danger. Their enemies include eagles, and foxes.

Scientific classification. Hares are in the rabbit and hare family, Leporidae. They belong to the genus *Lepus*.

See also **Animal** (picture: Animals of the polar regions); **Jack rabbit; Rabbit; Snowshoe hare.**

Hare Krishna. See **Cult.**

Hare system. See **Proportional representation.**

Harebell. See **Bluebell.**

Harelip. See **Cleft palate.**

Harem is the women's section of a household in some Middle Eastern and Asian countries. The word may also refer to the women who live there. The term comes from the Arabic word *haram,* meaning *forbidden.*

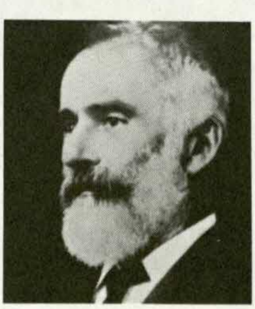
Traditionally, a harem was secluded and was open only to family members. The women cooked, raised children, and did other work in privacy, away from men except for their husband, sons, brothers, and fathers. Many harems housed the four wives permitted by Islam, the religion of the Muslims. A number of Turkish sultans and other wealthy rulers had large harems, which included their wives plus many mistresses, servants, and female relatives of the men. But such harems were rare because they were expensive.

Today, the practice of marrying more than one wife is forbidden by law in most countries. Middle Eastern women have become less secluded. Many attend coeducational schools and work outside the home. As a result, harems have nearly disappeared, though they still exist among a few ruling families.

Hargrave, Lawrence (1850-1915), an Australian pioneer in aviation, conducted many experiments involving the principles of flight. His work in Australia laid the foundation for the development of modern aircraft. When he began his research in the 1880's, most people believed that it was impossible for machines to fly through the air.

Hargrave built many models, usually of small size and simple construction. At first, he concentrated on designing and testing model aeroplanes propelled by flapping wings. In 1890, he constructed a flapping-wing model driven by compressed air. The model flew 110 metres. In 1893, he became interested in the way birds are sometimes lifted off the ground by the motion of air above their wings. He experimented with kites and discovered that a kite with a convex upper surface pulled twice as hard as one with flat surfaces. He went on to construct box kites. At Stanwell Park, in New South Wales, in 1894, four box kites lifted him 5.3 metres above the ground.

Hargrave also experimented with methods of propelling aircraft. He built models powered by elastic bands, clockwork, compressed air, steam, and internal combustion engines. He invented a rotary engine driven by compressed air and, later, by steam. Similar engines driven by petrol powered many early aeroplanes.



Lawrence Hargrave

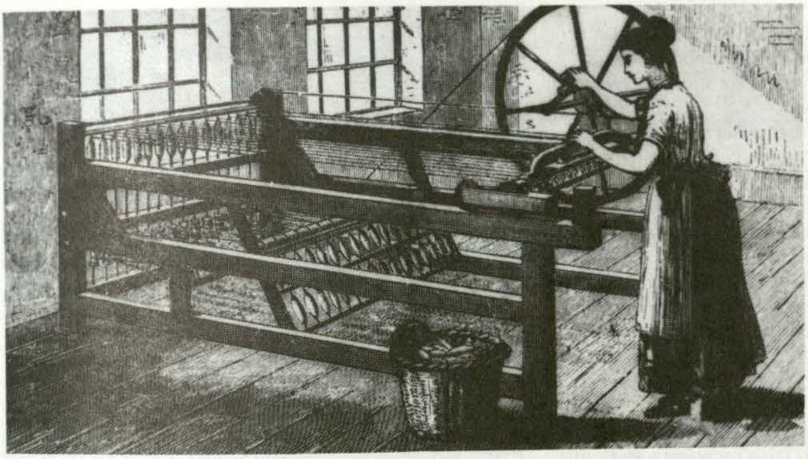
Hargrave was born at Greenwich, near London, and was educated at Queen Elizabeth's Grammar School at Kirkby Lonsdale, in Westmorland. In 1866, he emigrated to Australia and worked as an engineer with a shipping company. In the 1870's, he joined a series of expeditions to New Guinea. In 1877, he was elected a member of the Royal Society of New South Wales. In 1879, he became an assistant astronomical observer at the Sydney Observatory. Five years later, he resigned from this post to devote himself to research into the principles of aeronautics. Hargrave also experimented with water skis and hydroplanes.

Hargraves, Edward Hammond (1816-1891), an Australian goldminer, discovered gold near Bathurst in New South Wales, Australia, in 1851. He was not, as some people suppose, the first person to find gold in Australia. Several other men had found specks of gold near Bathurst early in the 1800's. A convict claimed to have found gold specks in 1815. A surveyor named James McBrien had also discovered specks of gold near Bathurst in 1821. At this time the government feared that the discovery of goldfields would lead to riots among the convicts. But by 1851, the developing colony of New South Wales needed gold to finance its overseas trade. The government offered a reward for the discovery of the first payable goldfield. Hargraves was given the credit and the reward by the government for this discovery. Hargraves was, in fact, away in Sydney when his two partners, John Lister and William Tom, panned the first payable gold. They found it on April 7 at Ophir, at the point where Lewis Ponds and Summerhill Creek meet. In granting its reward, the New South Wales government took into consideration the fact that Hargraves had led the team and given Lister and Tom the benefit of his gold-mining experience.

Edward Hargraves

Hargraves was born at Gosport, Hampshire, in Britain and educated at Brighton Grammar School. He settled in New South Wales in 1832 and worked as a grazier for many years. In 1849, he decided to join the gold rush in California. He had little success there, but he noticed that the gold country of California resembled the land near Bathurst. Hargraves returned to Australia in 1851. He set off on February 12, with John Lister acting as his guide, down the course of Lewis Ponds searching for gold. He washed five or six pans of earth and discovered the grains of gold he was looking for. The Colonial Secretary in Sydney was not impressed with the amount of gold that Hargraves had found. Then Hargraves' partners, Lister and Tom, discovered over 100 grams of gold at Ophir. They sent it to Hargraves in Sydney, and officials proclaimed the discovery of gold.

Hargreaves, James (1722?-1778), invented the spinning jenny, the first commercially successful machine to spin many threads at a time. He turned the spindles of



The spinning jenny invented by James Hargreaves was operated by a large wheel. When a worker turned the wheel, spools or spindles pulled and twisted the fibres. The spinning jenny replaced the slower one-thread spinning wheel, and made it possible for spinners to keep up with the weavers' demand for yarn.

several spinning wheels upright and placed them in a row. He then added a frame which alternately held and pulled the *rovings* (crude twists of cotton) used to make the thread. Hargreaves patented the jenny in 1770, though he is thought to have invented it in 1764. John Kay's flying shuttle had doubled the amount of cloth that weavers could produce, and Hargreaves' invention supplied the weavers with enough thread to make the cloth. The term *jenny,* a derivation of the word 'engine', was in use at the time to describe any mechanical device. Some historians have also suggested that it was the name of Hargreaves' daughter.

Hargreaves was a weaver in Standhill, England, and first used the jenny at home. He then sold some machines. The sales made his patent invalid, and he was never rewarded for his invention. Local spinners worried that the increased amount of yarn the jenny spun might cost them their jobs. They burned Hargreaves' machine and drove him from the town. He moved to Nottingham in 1768, and helped found a prosperous spinning mill. His machine was used in the mill. Other manufacturers used the jenny without paying him. Hargreaves lived comfortably during the last years of his life. But he was never as rich as he might have been.

See also **Crompton, Samuel; Spinning; Spinning jenny.**

Hari, Mata. See Mata Hari.

Hari-kari. See Hara-kiri.

Haringey (pop. 187,300) is a borough in Greater London. It includes the former boroughs of Hornsey, Tottenham, and Wood Green. Haringey is situated in north London. Its industries include confectionery and engineering. Tottenham Hotspur association football club and Haringey Stadium are located in the borough. Bruce Castle Museum contains local archives, a section on the history of the postal service, and a military section. The residential area of Hornsey takes in attractive suburbs in Crouch End, Highgate, and Muswell Hill. Finsbury Park and Queen's Wood are also in the borough. Wood Green has an attractive covered shopping centre. The borough contains Alexandra Palace, from which the British Broadcasting Corporation began transmission of the world's first regular television service in 1936. In 1980, a disastrous fire destroyed much of the building.

Harington, Sir Charles Robert (1897-1972), a British chemist, made important discoveries in biochemistry. He wrote several papers about the working of the thyroid gland. He synthesized *thyroxin,* a substance that increases the metabolic rate. Harington was born at Llanerfyl, in Powys, and educated at Malvern College and Cambridge University. He became professor of pathological chemistry at University College, London, and, later, director of the National Institute for Medical Research.

Harkins, William Draper (1873-1951), an American chemist, helped to clarify thinking on the nature of the atom. In 1927, he described a particle of matter, now called the *neutron,* which he reasoned must exist within the atom. He believed that the neutron could be formed from a positively charged proton and a negatively charged electron which combined in a way that neutralized their charges. James Chadwick's discovery of the neutron in 1932 confirmed this theory. Harkins was born in Titusville, Pennsylvania.

Harlech is a village in Gwynedd, Wales. Harlech Castle stands on a cliff overlooking marshes fringing Tremadoc Bay. The castle is in ruins, but has a magnificent gateway. Edward I built the castle in 1285. In 1468, during the Wars of the Roses, the Yorkist supporters captured it from the Lancastrian supporters. In the English Civil War, the castle was long held by Royalist forces.

Harley Street is in Westminster, in London, and runs southwards from Marylebone Road to Cavendish Square. It has long been associated with the medical profession, and many leading doctors and surgeons have their consulting rooms there. Many famous people have lived in Harley Street, including the geologist Sir Charles Lyell, the Victorian statesman W. E. Gladstone, and the artist J. M. W. Turner. Harley Street is also the site of Queen's College, a girls' school founded in 1848.

Harlow (pop. 73,500) is a local government district and a new town in Essex, England. Harlow lies on the Hertfordshire border, about 32 kilometres from London. The town's industries include food processing and publishing, and manufacture of electronics goods, glass products, and pharmaceuticals. Historic buildings in Harlow include the Harlowbury Chapel, dating from the 1100's, and St. Andrew's Church, dating from the 1300's.

Harlow, Harry Frederick (1905-1981), was an American psychologist. He provided new understanding of human behaviour and development through studies of the social behaviour of monkeys.

Harlow's research showed that maternal love and close social contacts are necessary at an early age for the normal development of behaviour. He studied the behaviour of monkeys that had been taken from their mothers at birth and given dummy mothers made of wire or cloth. The female infant monkeys responded to the dummy mothers as though they were real monkeys. However, these infant females, deprived of the care and affection of their natural mothers, did not develop maternal instincts. Harlow also found that monkeys that had been raised in isolation did not get along well with other monkeys.

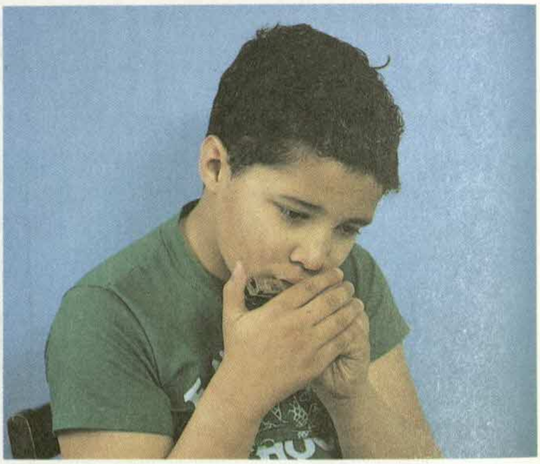
Harlow was born in Fairfield, Iowa, and graduated from Stanford University in 1927. He received a Ph.D. degree in psychology from Stanford in 1930. He served on the faculty of the University of Wisconsin from 1930 until he retired in 1974.

Harmattan is a cool, extremely dry wind that forms over the Sahara and blows westward or southwestward to the African coast. It blows during the dry season from December to February. The harmattan is relatively cool because the Sahara is cool at that time of year. Many harmattans carry great quantities of fine dust from the Sahara. The turbulence in well-developed harmattans can be dangerous to aeroplanes.

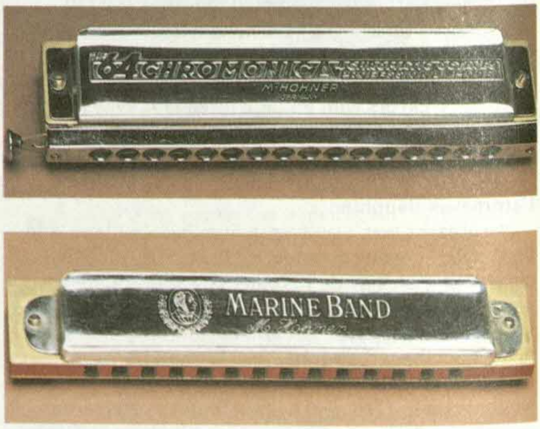
Harmonica is the name given to two simple musical instruments. The best known of these is the *mouth organ.* In this instrument, metal reeds are inside a case. The edge of the case has separate blowholes for each reed. The instrument is played either by blowing or sucking the air through these holes. The mouth organ is easy to play and is popular in the home. Such experts as Larry Adler have played the mouth organ in concerts and with orchestras.

The mouth organ dates back to two instruments developed in the 1820's. The first was the *aura,* which was patented by Friedrich Buschmann of Germany in 1821. The other, called the *symphonium,* was patented by Charles Wheatstone of England in 1829.

The second type of harmonica, called the *glass harmonica,* was invented in 1763 by Benjamin Franklin. He is said to have used the idea of an Irishman named Richard Pockrich. Franklin's instrument was a series of bowl-shaped glasses arranged in order of size on a spindle. The spindle was turned, and the rims of the glasses were moistened in a water-filled trough below. Music was made by holding the finger against the wet rim as the rim rotated. Wolfgang Amadeus Mozart composed a quintet for the glass harmonica, flute, oboe, viola, and violoncello.



The harmonica is a small wind instrument with reeds that produce tones when the player exhales or inhales.



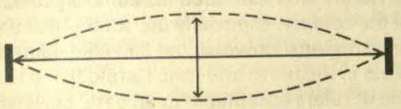
The chromatic harmonica, *top,* produces more tones and a more harmonious melody than the diatonic harmonica, *bottom.*

Harmonics are the components of a musical tone. A tone is actually a blend of several separate tones. This blend, called a *composite tone,* is caused by a set of vibrations, such as those made by a musical instrument or the human voice. For example, a violin string vibrates over its entire length. But it also vibrates in segments, called *partials,* which are shorter than the total length of the string. The string vibrates in segments such as a half, a third, or a fourth, of the string. Each vibrating segment produces a separate tone, called an *overtone.*

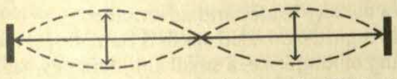
The *first harmonic,* called a *fundamental,* is the lowest tone. It results from the vibration of the whole violin string. Other harmonics, called *overtones,* come from the various vibrating segments. The *second harmonic,* also called the *first overtone,* vibrates in two segments at a frequency twice that of the fundamental, and is an octave higher. Other overtones have vibration frequencies three or more times that of the fundamental. In most cases, the higher overtones are produced with less *intensity* (loudness) than the lower ones. The fundamental and overtones combine to produce one complete tone that is the same pitch as the fundamental.

The number and intensity of a tone's harmonics determine the *timbre* (quality) of the tone. The timbre is largely responsible for the different sounds produced by various musical instruments, even when they play the same note. In the human voice, harmonics create vowel

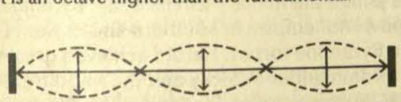
Elements of a musical tone



The fundamental is also called the *first harmonic.* It is the lowest tone produced by a vibrating violin string.



The first overtone, or *second harmonic,* vibrates in two segments at a frequency twice that of the fundamental. It is an octave higher than the fundamental.



Other overtones have vibrations three or more times that of the fundamental. The *second overtone* vibrates in three segments a fifth higher than the first overtone.

sounds and the different tone qualities that separate the sound of one voice from another. Sounds with strong, high harmonics are often called *resonant* or *rich* in quality, and sounds with relatively low, weak harmonics are called *soft* or *muted.*

See also **Sound** (Sound quality); **Tone.**

Harmonium is a reed organ. Its keys control the flow of air across metal reeds. Air pressure is provided by bellows operated by the player's feet. Below the keyboard are levers which may be pressed by the knees of the player to make the tone louder or softer. Above the keyboard are "stops" by which the quality of tone may be changed. The harmonium was developed in France early in the 1800's. Today, the harmonium is most commonly played in India.

Harmony is the study of musical chords and their relationships. Most chords consist of three or four notes sounding at the same time. A melody is *harmonized* when chords are added to it.

Composers used traditional harmony from about 1680 to 1900. In traditional harmony, chords are built in *thirds* (two steps apart in the scale). The bottom note is called the *root* of the chord. Chords consisting of two thirds are *triads.* Those with three thirds are *sevenths.*

One form of traditional harmony is called *functional* harmony. In functional harmony, all chords are related to one of three basic chords of a key. The main chord is the *tonic,* which is based on the first note of the scale. The others are the *dominant,* based on the fifth note, and the *subdominant,* based on the fourth note. All other chords in a key are related to one of these three chords.

A major or minor triad is called a *consonant* chord. All other chords are called *dissonant* and, in traditional harmony, must be smoothly *resolved* (connected) to a consonant chord.

The history of harmony is the development of *chromatic* chords and *modulations.* Chromatic chords include tones outside the key. Modulation is changing from one key to another. Many composers use chromatic chords and modulations to add expression and harmonic variety to a composition.

After 1900, many composers abandoned traditional and functional harmony. Some have used streams of triads or sevenths in parallel motion. Some have built their chords out of intervals other than thirds. Many modern composers have also used triads in two or more keys sounded at the same time, or mixtures of notes sounded as chords.

See also **Rameau, Jean Philippe.**

Harmsworth is the name of a British family of newspaper owners and politicians.

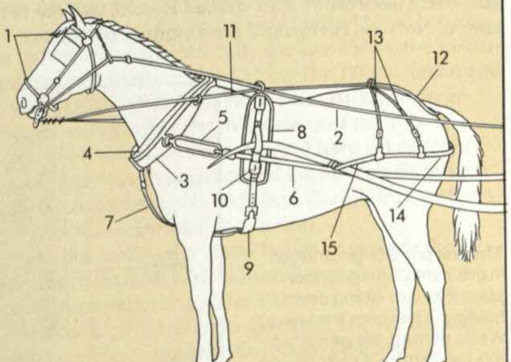
Alfred Charles William Harmsworth (1865-1922), Viscount Northcliffe, was one of Britain's greatest journalists. He founded the *Daily Mail* in 1896, and the *Daily Mirror* in 1903. He bought the London *Evening News* and the *Weekly Dispatch* (later the *Sunday Dispatch*), and, in 1908, he became the chief proprietor of *The Times.* He saved *The Times* from closing down, and made it a profit-making newspaper again. Northcliffe was born near Dublin, Ireland.

Harold Sidney Harmsworth (1868-1940), Viscount Rothermere, helped his brother Alfred in his newspaper ventures. He founded the *Sunday Pictorial* (later the *Sunday Mirror*) in 1915. After Northcliffe's death, Rothermere took over control of the group. He was born in London.

Harness is the equipment placed on a horse or other animal that enables it to pull a vehicle with its shoulders.

Parts of the harness

All parts of the harness work together to enable the driver to control and guide the horse and to help the horse pull the load. Different types of harnesses are used for different purposes. The light harness shown below is used to pull a buggy. Horses must wear stronger harnesses when they pull heavier loads.



1. Bridle
2. Rein
3. Collar
4. Hame
5. Hame tug
6. Trace
7. Breastplate
8. Backband
9. Girth
10. Shaft tug
11. Side check
12. Crupper
13. Hip straps
14. Breeching
15. Holdback strap

The basic parts of a harness are the bridle, reins, collar, hames, and traces. Other parts may be added for special situations. Most parts of a harness are made of leather and are held in place by metal buckles and clasps.

The bridle is used to control the animal's movements. It consists of straps that fit securely on the animal's head and a metal bit that fits in its mouth. The reins are attached to the bit and must be long enough to reach the vehicle's driver. The collar goes around the animal's neck at the shoulders. The hames are two curved pieces attached to each side of the collar. The traces are two long straps, ropes, or chains that connect the harness to the vehicle. One end is attached to the hames and the other is hooked to the vehicle. Sometimes an animal is harnessed between two long wooden poles called shafts that are attached to the vehicle.

Harold was the name of two early English kings.

Harold I (?-1040), called Harefoot, was the son of Canute and Aelfgifu of Northampton. Harold was made king when Canute died in 1035, although his half-brother, Hardecanute, had a better claim to England. Harold's mother dominated his reign, which was marked by acts of cruelty.

Harold II (1022?-1066) succeeded Edward the Confessor and was the last Anglo-Saxon king of England. In 1053, Harold succeeded his father, Godwin, as the Earl of Wessex. This made him the most powerful man in England. He continued his father's resistance to Norman influence, which had become strong in England under King Edward's patronage.

When Harold was shipwrecked in 1064, he fell into the hands of Duke William of Normandy, later known as William the Conqueror. William forced Harold to swear that he would support William's claim to the English throne. But when Edward the Confessor died, the English nobles chose Harold king. When Harold accepted, William invaded England to fight for the throne. Harold was defeated and killed at the Battle of Hastings, in October 1066 (see **Hastings, Battle of**). England then came under Norman rule.

See also **Norman Conquest**.

Harold I (860?-940?), also spelled Harald, was the first king of Norway. He formed the Kingdom of Norway about 900, after defeating a number of local rulers.

Harold Halfdansson succeeded his father as ruler of Vestfold, a small kingdom in what is now southeastern Norway. Harold later extended his authority to other areas of the country, especially the southern and western coastal regions. However, he had little control over local rulers in the north and east. Harold failed to establish a line of rulers acceptable to all parts of Norway. As a result, some of his successors had to reconquer most of the country.

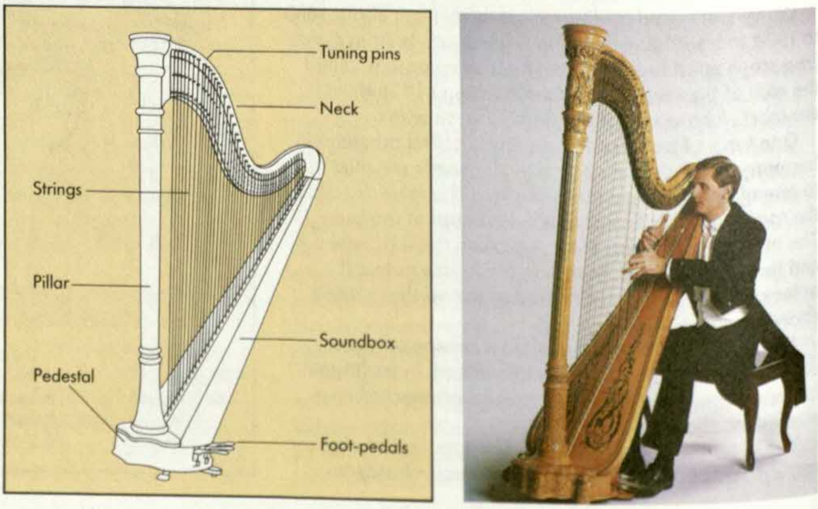
Harold III (1015-1066) was king of Norway. He gained fame as a military leader and adventurer.

Harold Sigurdsson, also spelled Harald, was the son of the king of Ringerike, a small kingdom in what is now southeastern Norway. In 1030, Harold fled Norway to escape his enemies, travelling to Sweden and Russia. In 1034, he joined the military forces of the Byzantine Empire, a powerful empire in southern and eastern Europe. With the Byzantine forces, Harold achieved great success as a commander in Sicily and the Middle East.

In 1046, Harold returned to Norway to share the rule of the country with his nephew King Magnus I. Magnus was the heir of Hardecanute (also called Hardeknud), who had been king of both Denmark and England. Magnus died in 1047, and Harold became the sole ruler of Norway. Then Harold, as Magnus' heir, claimed the Danish throne and later the English throne. Harold fought for 17 years to gain control of Denmark, but finally acknowledged its independence in 1064. He invaded England in 1066, but was killed in the Battle of Stamford Bridge, near the city of York. Harold founded the city of Oslo about 1050.

Harp is one of the oldest known stringed instruments. The chief instrument in the harp family is the large concert harp. Smaller harps are often used in folk music.

The modern concert harp is a large, triangular wooden instrument about 180 centimetres tall. The wood is often gilded and decoratively carved. The harp rests on a base called the *pedestal.* A perpendicular column called the *pillar* rises from the front of the pedestal. A hollow *soundbox,* which amplifies the sound, projects at an angle from the rear of the pedestal. The pillar and the soundbox are joined at the top by a curved *neck.*



The harp is a large stringed instrument. The performer plays the harp sitting down, holding it between the knees. While playing, the performer tilts the harp so it rests against the right shoulder. The harp is played by plucking the strings with the fingers. The performer controls the pitch of the strings by depressing any of seven foot-pedals.

Forty-seven strings of different lengths and thicknesses are stretched between the neck and the soundbox. Tuning pins in the neck set the strings to the notes of the scale over a range of 6½ octaves. Seven foot-pedals extend from the pedestal. When a pedal is depressed, it raises the pitch of its corresponding strings a half-tone or whole-tone, depending on the distance the pedal is depressed. This mechanism, called *double action,* enables the performer to play in any key or sequence of keys.

The performer sits with the harp between the knees, tilting it so it rests against the right shoulder. The player plucks the strings with the thumb and first three fingers of each hand and operates the pedals with the feet.

Early forms of the harp existed in several ancient Near Eastern civilizations. In Europe, the first harps appeared in the 700's in Ireland, where the harp is now a national symbol.

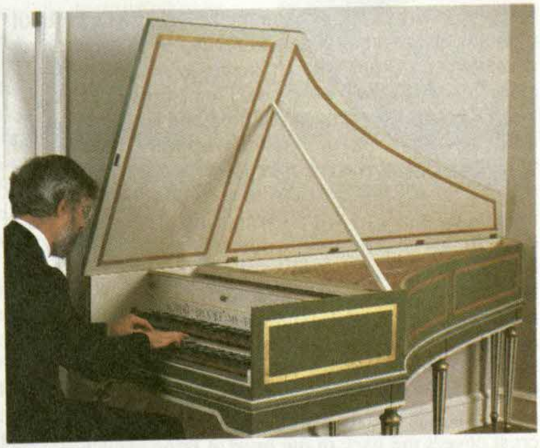
Harpoon is an arrow-shaped weapon that is used to spear large fish and whales. Whaling harpoons are fired from powerful guns. A long, coiled line is tied to the harpoon. When the harpoon strikes the whale, the weapon's barbed point becomes anchored in the skin of the whale. Famous harpooners of the 1800's hurled harpoons by hand from the bow of small boats. Today, hand harpooning is practised by Eskimos. See also **Whale** (The Basque people; Hunting techniques).

Eskimos use hand harpoons to spear the whales. Only peoples who rely on whales for food may hunt whales.

Harpsichord is a musical instrument that resembles a small piano. A harpsichord can be played as a solo instrument, in a chamber-music ensemble, or with an orchestra.

A harpsichord is smaller and lighter than a piano and has from one to three keyboards, usually called *manuals.* Like a piano, it produces sounds by causing metal strings to vibrate. But the strings of a harpsichord are plucked, not struck like those of a piano. As a result of these differences in size and mechanical action, a harpsichord produces a tone that is clearer and livelier than that of a piano.

The strings of a harpsichord are stretched over two strips of wood called the *bridge* and the *nut.* The bridge is glued to a thin sheet of wood called the *soundboard.* The nut is glued to a block of wood that runs parallel to the keyboard and holds the tuning pins. When a string is plucked, its vibrations are transmitted by the bridge to the soundboard. The soundboard then transmits the vibrations to the sides and bottom of the instrument, called the *case,* and into the air.



A harpsichord is a musical instrument that looks somewhat like a small piano. It has from one to three keyboards, usually called *manuals.* The instrument shown above has two manuals.

A note is produced by the plucking of the strings. Usually two or three strings are plucked. Each string is plucked by a small piece of quill or leather called a *plectrum.* The plectrum sticks out from a piece of wood called a *jack.* When a player strikes a key, the jack rises and the plectrum plucks a string. When the player releases the key, the jack drops. Then, when the plectrum touches the string, it swings back on a wooden pivot called a *tongue,* and passes the string without plucking it a second time. A *damper* (felt pad) on the jack then stops the string from vibrating.

Most harpsichords have two or three strips of wood called *registers* that are used to move the sets of jacks into or out of contact with their sets of strings. Often one set of strings sounds an octave higher than the other, and can be used to add brilliance to the sound.

The harpsichord first appeared in the 1300's, but no one knows who invented it. By the late 1500's, the instrument had become popular. During the 1600's, Italian and Flemish craftworkers built simple harpsichords to accompany solo performers. Musicians of the 1700's played richly decorated two-manual harpsichords. Famous composers of harpsichord music include Johann Sebastian Bach, François and Louis Couperin, Girolamo Frescobaldi, and Domenico Scarlatti.

By the late 1700's, the piano began to replace the harpsichord. But the harpsichord has regained some musical importance since the 1940's.

See also **Bach** (family); **Couperin, François; Scarlatti, Domenico; Music** (picture: Keyboard instruments); **Piano** (History).

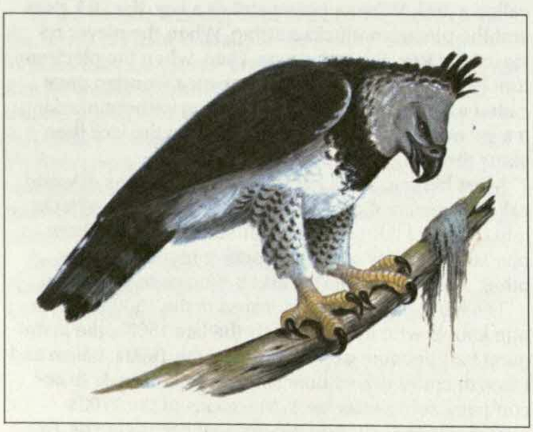
Harpur, Charles (1813-1868), was one of the first Australian poets to realistically portray Australian life and landscape. He adapted English poetic diction to Australian needs. Harpur was not completely successful, but he influenced later poets such as Henry Kendall. His works include *Thoughts* (1845), *A Poet's Home* (1862), and *The Tower of the Dream* (1865). Harpur was born in Windsor, New South Wales.

Harpy, in Greek and Roman mythology, was a frightful monster that was half woman and half bird. *Harpy* comes from a Greek word meaning *to snatch.* Harpies stole food from their victims and left a dreadful smell behind them. They tormented the blind king Phineus until the sons of the north wind, who were travelling with the Argonauts, drove the Harpies away. Phineus then told the Argonauts how to pass through the Clashing Rocks (see **Argonauts**). According to Virgil, Aeneas also met the Harpies on his wanderings.

Harpy eagle is a large bird of prey that lives in lowland tropical forests. Harpy eagles inhabit southern Mexico, eastern Bolivia, southern Brazil, and northern Argentina. Harpies weigh more than 4.5 kilograms and stand 90 centimetres tall. Their wingspread reaches 2 metres. The harpy eagle's head and neck are grey, its chest is black, and its underparts are white. A long black crest covers the back of the head. A large black beak and massive yellow feet distinguish the bird.

This powerful eagle uses its strength to capture monkeys, sloths, opossums, and porcupines. Harpies build large stick nests in tall trees. Mating pairs only breed every other year and the female lays one or two eggs. Harpy eagles are named after the "flying monsters" in ancient Greek and Roman mythology (see **Harpy** [in mythology]).

Scientific classification. Harpy eagles belong to the hawk family, Accipitridae. They are *Harpia harpyja.*



The harpy eagle is a South American bird of prey.

Harquebus, also called *arquebus,* was an early handgun. The weapon consisted of a short metal tube attached to a wooden *stock* (handle). A soldier loaded the weapon through the muzzle with black powder and a round bullet. A *touchhole*—a vent for carrying fire to the bullet and powder—led through the barrel to an open *pan.*

The pan contained a small amount of powder. The gunner lit a slow-burning wick, called a match, held by an S-shaped *serpentine.* To fire the weapon, the gunner pulled a trigger attached to the lower end of the serpentine. This action applied the lighted match to the powder in the pan. This type of firing mechanism was the *matchlock.*

During the 1500's, gunsmiths developed another device, called the *wheel lock.* A *cock* held a pebble against a toothed wheel. The trigger spun the wheel, and set off sparks which ignited the powder. Wheel locks were safer to use than matchlocks, but they were much more expensive.

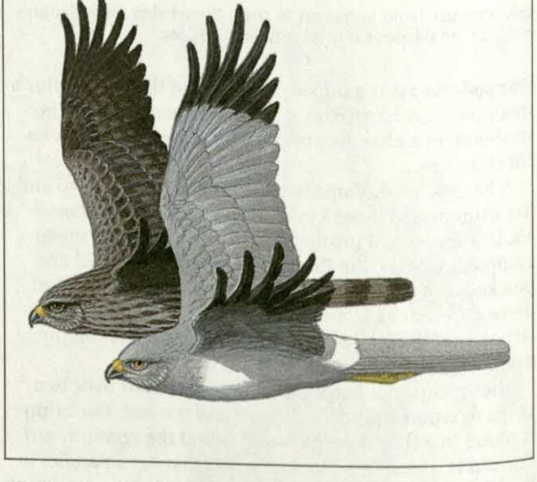
The harquebus was an early type of handgun loaded through the muzzle. It had a matchlock firing mechanism operated by a trigger. Infantry soldiers first used harquebuses in the 1400's.

The harquebus developed from the small hand cannon first used during the 1300's. The hand cannon was a heavy weapon and required supports. Foot soldiers in the 1500's preferred to use muskets. But the harquebus survived for use by mounted troops in the early 1600's.

See also **Flintlock; Musket.**

Harrier is the name of ten species of slim-bodied birds of prey. They all grow to about 50 centimetres in length, and have long wings and tail. They hunt by patrolling marshes and wet grassland areas, snatching small rodents or young waterbirds with their long legs. Harriers have owl-like faces, with ears specialized to locate prey in dense vegetation, such as reed beds. Male harriers are generally bluish grey, and most females are brown. Most harriers nest among vegetation on the ground, but the Australian spotted harrier nests in trees. Harriers lay 5 to 7 pale coloured eggs, at intervals of a few days. During courtship, harriers often pass food to each other. For example, the female European hen harrier rolls over on her back and catches prey dropped to her by the male. Harriers also have the habit of transferring prey from one foot to the other.

Scientific classification. Harriers belong to the family Accipitridae, genus *Circus.* The hen harrier is *C. cyaneus,* the Australian spotted harrier is *C. assimilis.*



The hen harrier lives across the Northern Hemisphere. Like many harriers, the male is grey and the female is brown.

The harrier has been used to hunt hares.

Harrier is a breed of dog that was developed for the sport of hunting hares. It has a keen sense of smell and can move quickly. The harrier is sturdy and heavy-boned, with catlike feet. Most harriers have a short, white coat with black and tan patches, and floppy ears. They look like small foxhounds or large beagles. Harriers stand from 48 to 53 centimetres high at the shoulder and weigh 16 to 25 kilograms.

The breed probably originated as early as the 1000's. Its ancestry is unclear, but many breeders believe that the harrier developed in France from crossing the greyhound, the bulldog, and the fox terrier.

Harriman, W. Averell (1891-1986), an American statesman and businessman, was one of the leading diplomats of the mid-1900's. During World War II (1939-1945), Harriman arranged the sending of weapons and other supplies to Great Britain and the Soviet Union under the Lend-Lease programme. He later served as U.S. ambassador to each of these countries.

Still later, Harriman became secretary of commerce from 1946 to 1948 under President Harry S. Truman. From 1948 to 1952, Harriman administered the European operations of the European Recovery Program, popularly known as the Marshall Plan. He served as governor of New York from 1955 to 1958.

Harriman was assistant secretary of state for Far Eastern affairs from 1961 to 1963, when he became undersecretary of state for political affairs. In that post, he negotiated a 1963 treaty with Britain and the Soviet Union banning many kinds of nuclear tests. Harriman resigned as undersecretary in 1965 but remained in the State Department as ambassador at large. He served as chief U.S. negotiator at the Paris peace talks on the Vietnam War in 1968 and 1969.

William Averell Harriman was born in New York City. He inherited a fortune from his father, the railway executive E. H. Harriman. The younger Harriman served as chairman of the board of Union Pacific Railroad from 1932 to 1946.

Harris, Sir Arthur (1892-1984), was an English commander in chief of the Royal Air Force's Bomber Command from 1942 until 1945. He believed that the military power of a hostile country could be crushed by the systematic destruction of its war industries from the air. He organized heavy raids on Germany during World War II. His courage and determination inspired Bomber Command. Under his leadership, it played a decisive part in the Allied victory in Europe.

He was born in Cheltenham, Gloucestershire, and named Arthur Travers Harris. He served in the Royal Flying Corps in World War I and joined the RAF in 1919. He became a marshal of the Royal Air Force in 1945.

Sir Arthur Harris

Harris, Benjamin (1660?-1720), published the first newspaper in America. As a bookseller in his native London, he was punished for circulating "false" pamphlets about Roman Catholics and Quakers. He fled to America in 1686. On Sept. 25, 1690, he published *Publick Occurrences Both Forreign and Domestick* in Boston. He planned to issue his "newes-paper" at least once a month, but its scandalous stories about the French antagonized colonial authorities, and no other issues were printed. See also **Literature for children** (The Puritans; picture).

Harris, Howel (1714-1773), was one of the founders of Welsh Methodism. He was born at Trefecca, now in Powys, Wales. Harris was converted to Methodism in 1735. He soon became well known for his evangelism, preaching to large crowds. In 1737, he met Daniel Rowland, another convert. Together they launched their own brand of Calvinistic Methodism. Harris broke with Rowland in 1751 and retired to Trefecca, where he formed a Protestant religious community.

Harris, Joel Chandler (1848-1908), an American author and journalist, became famous for his Uncle Remus stories. Uncle Remus is a former slave who has become a beloved servant of a Southern family. He entertains the young son of the family by telling him traditional animal fables, using Southern African-American dialect of the 1800's. In these stories, animals behave and talk like human beings. Among the best-known characters of the stories are Brer (Brother) Rabbit, Brer Fox, Brer Bear, and Brer Wolf. Many literary critics and folklorists today agree that these tales contain thinly veiled racial allegories. They point out that the trickster in the stories, though the weaker figure, usually wins.

Harris was born in Eatonton, Georgia. From 1862 to 1866, he worked as a printer on a plantation near his home. The plantation owner, Joseph Addison Turner, published a newspaper called *The Countryman.* Turner introduced Harris to literature and encouraged him to write essays and poems. Harris became acquainted with the slaves on the plantation. He learned their customs and language and listened to their stories. This material formed the basis of his most successful writings.

From 1876 to 1900, Harris wrote for the *Atlanta Constitution,* in which his first Uncle Remus stories appeared. He later collected the stories in book form as *Uncle Remus: His Songs and His Sayings* (1880). Readers enjoyed its humour, and critics called it an important record of manners and oral folk tales of African-Americans of the Southeastern United States. The book's popularity led Harris to publish more collections of Uncle Remus stories, including *Nights with Uncle Remus* (1883) and *Uncle Remus and His Friends* (1892).

Harris also wrote many stories and novels about life in the South during and after the Civil War (1861-1865). Collections of such stories as *Free Joe and Other Georgian Sketches* (1887) gave him a separate though less celebrated reputation from his Uncle Remus tales. In *On the Wing of Occasions* (1900), Harris introduced Billy Sanders, the Sage of Shady Dale. Through Sanders, Harris expressed the opinions of many rural Georgians.

Harris, John (1754-1838), a surgeon, served with the New South Wales Corps in Australia. He was born at Moneymore in Ireland and studied medicine at the University of Edinburgh, Scotland. He arrived in Sydney in 1790. In 1798, he built Experiment Farm Cottage, which still stands at Parramatta. In 1811, he supported his superior, Major George Johnston, at his court martial over the Rum Rebellion. See also **Rum Rebellion.**

Harris, Lawren. See **Group of Seven.**

Harris, Reg (1920-1992), became the first Englishman to win the world professional sprint cycling championship. Harris was born at Bury, in Greater Manchester. In the mid-1940's, he was the national amateur sprint cycling champion and in 1947 he won the world amateur championship. He represented Britain in the 1948 Olympic Games in London and won two silver medals. Harris became a professional in 1949 and won the world professional championship in that year. Later, he made a comeback and, in 1974, won the national professional sprint championship. He retired in 1975.

Harris, Rolf (1930-), an Australian entertainer and singer, first became well known when his song "Tie Me Kangaroo Down, Sport" was a great success in 1960. His version of the song "Two Little Boys" sold over 900,000 copies in the first 15 weeks in Britain after it was released in 1969. His other hit songs include "Jake the Peg." Harris was born in Perth and went to England in 1952 to study art.

Racing cyclist Reg Harris won the British professional sprint championship in 1974. He was making a comeback 25 years after winning the world professional sprint championship.

Harris, Roy (1898-1979), was an American composer. He became famous for creating and promoting a distinctly American style of classical music. Harris greatly influenced a number of other American composers, including Aaron Copland and Walter Piston.

Harris wrote 16 symphonies, 14 for orchestra and 1 each for band and for chorus. His Symphony No. 3 (1939) is one of the most frequently performed of all symphonies written by American composers. Harris often used themes from American folk music in his compositions. For example, the themes of a number of American folk songs appear in his Symphony No. 4 (1940), also known as the *Folk Song Symphony.* He based his symphonic overture *When Johnny Comes Marching Home* (1935) on the American folk song of the same name. Harris also composed music for bands and chamber groups as well as choral music and works for solo piano.

Harris was born in a log cabin in Lincoln County, Oklahoma. He began his musical studies in California. From 1926 to 1929, Harris studied in Paris under the famous music teacher Nadia Boulanger.

Harrison, Benjamin (1833-1901), was president of the United States from 1889 to 1893. A Republican, he also oversaw passage by Congress in 1890 of the Sherman Antitrust Act, which outlawed trusts or any other monopolies that hindered trade.

Harrison was born in North Bend, Ohio, U.S.A. His grandfather was William Henry Harrison, also a U.S. president. Benjamin Harrison was an army commander and a member of the U.S. Senate before becoming president. He lost his bid for reelection in 1892 to former President Grover Cleveland, the man he had defeated in 1888.

Harrison, Frederic (1831-1923), a lawyer and author, was a leading exponent of the Positivist philosophy (see **Comte, Auguste**). He wrote many works on history, literature, and philosophy, including *The Meaning of History* (1862) and *The Philosophy of Common Sense* (1907). Harrison was born in London. He became a barrister in 1858, and later taught jurisprudence and international law at Lincoln's Inn Hall, in London. He also lectured on Positivism and was a founder of the English Positivist Society.

Harrison, George. See **Beatles.**

Harrison, John (1693-1776), was a skilful maker of scientific instruments. In 1726, he made the first *gridiron compensating pendulum,* a pendulum that compensated for changes in length resulting from changes of temperature (see **Pendulum**). Harrison incorporated his pendulum in a chronometer, and this improved chronometer enabled sailors to calculate longitude much more accurately than they had been able to before (see **Chronometer**). Harrison was born in Foulby, West Yorkshire.

Harrison, William Henry (1773-1841), a president of the United States, served the shortest time in office of any U.S. president. He caught a cold on the day he was inaugurated, and he died of pneumonia 30 days later, on April 4, 1841. A Whig, he was the first president to die in office.

Harrison was born in Charles City County, Virginia, then a British colony. He received the nickname "Tippecanoe"—recalled in the 1840 presidential campaign slogan "Tippecanoe and Tyler too"—after defeating the Shawnee Indians in 1811 at the Battle of Tippecanoe in Indiana.

Harrod, Sir Roy (1900-1978), an English economist and writer, became known as an outspoken Liberal critic of restrictive government policies. His books include *International Economics* (1933), *Policy Against Inflation* (1958), *The British Economy* (1963), *Towards a New Economic Policy* (1967), and *Economic Dynamics* (1973). Harrod was born in Chelsea, London, and named Henry Roy Forbes Harrod. He joined the statistical department of the Admiralty in 1940, later serving in the Prime Minister's office and as an adviser to the International Monetary Fund.

Harrogate (pop. 141,000) is a local government district and town in North Yorkshire, England. Wensleydale and Nidderdale are in the district, which also includes the market towns of Ripon and Knaresborough (see **Dales**). Farming is the district's main industry, but Harrogate town has some light industries. It is also a tourist centre and stages conferences and exhibitions. See also **Yorkshire.**

Harrow. After farmers plough the ground, they must break the clods of earth into smaller pieces with a harrow before they plant seeds. Otherwise, the delicate shoots could not break upward through the heavy clods left by the plough. The first harrow used by primitive people was a tree limb with many smaller branches which was pulled over the soil. Later, wooden frames with teeth set in them were used. Today there are three general types: (1) the disc harrow, (2) the smoothing, or drag, harrow, and (3) the spring-tooth harrow.

The *disc harrow,* sometimes called a *disc,* is a set of sharp discs, from 40 to 80 centimetres in diameter, mounted on a shaft from 1.5 to 3 metres long. As the harrow is pulled forward the discs revolve, cutting the soil as they go. Disc harrows are sometimes made with two or three sets of discs mounted on shafts. If the soil is not very hard, a disc harrow can be used instead of a plough. This means that the farmer can plough and break the soil into pieces at the same time. When used in this way, a disc harrow is usually weighted to make the discs cut more deeply.

The *smoothing,* or *drag, harrow* is a set of two to four iron frames. Each frame is about 1.5 metres square and has rods running across it. Each rod has iron teeth which "comb" the soil as the harrow is pulled.

The *spring-tooth harrow* is an iron frame which may be up to 3 metres wide. Teeth made of springs shaped in a half circle are bolted into the frame. The teeth are sharpened to a spoon shape, and they tear the soil when the harrow moves.

Harrow (pop. 194,300) is a borough within the Greater London area. It lies northwest of London, and is well known for its independent school for boys, Harrow School. The school was founded in 1572 by John Lyon. Sir Winston Churchill was one of the school's most illustrious pupils. The restored Church of St. Mary, built in the 1100's, has a tall spire and a memorial to John Lyon.

Harsha (A.D. 590?-647) was an Indian king who ruled most of northern India from A.D. 606 to 647. He was also called Harsha-vardhana. Harsha was the first Indian monarch to establish a unified empire after the Huns from central Asia invaded India during the 400's and 500's. Harsha, the son of a king in the Ganges River Valley, had inherited the combined throne of two small kingdoms. He then conquered most of the neighbouring area. Harsha supported the development of philosophy and literature and wrote three well-known plays—*Nagananda, Ratnavali,* and *Priyadarsika.* After Harsha died, the empire soon broke up.

Hart (pop. 78,700), a local government district in Hampshire, England, is an agricultural area with some rich farmland. Farmers keep dairy cattle and grow a variety of crops, including hops. The district includes the National Gas Turbine Establishment, which tests aircraft engines for power and noise. Towns in the district include Fleet, Hartley Wintney, and Odiham. See also **Hampshire.**

Hart, Lorenz (1895-1943), was an American writer of lyrics of popular songs. He and the composer Richard Rodgers created songs for many musical comedies. This team produced its best work in the late 1920's and the 1930's. During that period, only Cole Porter rivalled Hart for satirical wit and freshness of rhymes. Hart's best-known songs include "Falling in Love with Love," "My Funny Valentine," and "Thou Swell."

Hart was born in New York City. He and Rodgers began to work together in 1919 and achieved their first success with *The Garrick Gaieties* (1925). They then created the songs for *Peggy-Ann* (1926), *A Connecticut Yankee* (1927), and other musicals.

Hart and Rodgers moved to Hollywood, California, U.S.A., in 1930 and composed songs for several films. After returning to New York City in 1934, they wrote songs for a number of musical comedies, including *On Your Toes* (1936), *Babes in Arms* (1937), *I'd Rather Be Right* (1937), and *Pal Joey* (1940).

See also **Rodgers, Richard.**

Hart, Moss (1904-1961), was an American playwright and director. He became famous for a series of witty comedies on American life that he wrote with George S. Kaufman. Their first success was *Once in a Lifetime* (1930), a satire about the film industry. Hart and Kaufman won the 1937 Pulitzer Prize for drama for *You Can't Take It With You,* a comedy about a family of lovable eccentrics. Their other works included *Merrily We Roll Along* (1934), *The Man Who Came to Dinner* (1939), and *George Washington Slept Here* (1940).

Hart wrote several plays by himself, including *Winged Victory* (1943), *Light Up the Sky* (1948), and *The Climate of Eden* (1952). He also wrote the stories for several musical comedies. *Face the Music* (1932) and *As Thousands Cheer* (1933) had music by Irving Berlin, and *Lady in the Dark* (1941) had music by Kurt Weill.

Hart wrote the scripts for several films, including *Gentleman's Agreement,* which won the 1947 Academy Award as the best film of the year. He directed many plays and musicals, including the hit musical comedy *My Fair Lady* (1956). His autobiography, *Act One* (1959), is an informative book about theatre life. Hart was born in New York City.

See also **Kaufman, George S.**

Hart, W. E. (1885-1943), an Australian aviator, was the first person to be awarded a pilot's certificate in Australia. The certificate was issued in December 1911. Hart, a Sydney dentist, taught himself to fly after buying a Bristol Boxkite aircraft for £1,300. He made several of the first cross-country flights in Australia. In 1911, he flew from Penrith to Sydney, reaching a height of 1,980 metres before landing at the Sydney Cricket Ground. In 1912, he won a 24-kilometre private race against an American pilot over a course from Sydney to Parramatta. In the same year, he became a member of the Royal Aero Club of Britain. During World War I, he was an instructor with the Australian Flying Corps. William Ewart Hart was born at Parramatta, in New South Wales.

Harte, Bret (1836-1902), was an American author who became famous for his colourful stories about the West. His best-known works describe the California gold rush days of the mid-1800's. Harte portrayed a variety of people, such as gamblers, miners, and prostitutes. He described their personal characteristics, including their natural form of speech. Harte's descriptions helped shape a movement in American fiction called *local colour writing.* This literary style tries to capture the feeling of a particular place and its people.

Harte was born in Albany, New York. His real name was Francis Brett Hart. He moved to California at the age of 18 and spent several years working at various jobs. After publishing several poems in 1857, he decided to be a writer. Two years later, Harte joined the staff of the *Northern Californian,* a newspaper in Union (now Arcata), California. In 1860, he wrote an editorial that criticized white Californians for their part in an Indian massacre. The angry townspeople forced him to resign.

From 1868 until early 1871, Harte served as editor of the *Overland Monthly,* a magazine published in San Francisco. The August 1868 issue included his story "The Luck of Roaring Camp." Californians disliked the story at first because it showed California life as rough and unsophisticated and was sympathetic to the tough gold rush miners. But the merit of the story soon gained Harte a nationwide reputation.

Harte's work in the *Overland* continued to gain popularity. His best-known writings from the magazine include two short stories, "The Outcasts of Poker Flat" (1869) and "Tennessee's Partner" (1869), and a humorous poem, "Plain Language from Truthful James" (1870), later published as "The Heathen Chinee." *The Luck of Roaring Camp and Other Sketches* (1870) was a collection of stories about life in California.

Harte became increasingly famous in the American East, and in 1871 he moved to Boston. There, he failed to fulfil the terms of a contract with the *Atlantic Monthly* magazine. He handed in several stories after their deadlines, and the *Atlantic* was generally unhappy with his work. Harte's popularity soon declined. His only novel, *Gabriel Conroy* (1876), received harsh criticism, and he became discouraged. Harte left the United States in 1878 and spent seven years as a diplomatic representative of the U.S. government in Germany and Scotland. He lived in London from 1885 until his death.

Hartebeest is a large African antelope. There are two main kinds, the *common hartebeest* and *Lichtenstein's hartebeest.* The common hartebeest is found in central and southwest Africa. Lichtenstein's hartebeest lives in southern Africa, especially Mozambique and Zambia.

Hartebeests grow from 1 to 1.5 metres high and weigh from 100 to 225 kilograms. The females are smaller than the males. Both the females and the males have curved horns. Hartebeests have a brown or reddish-brown coat. The common hartebeest is more reddish and slightly smaller than Lichtenstein's hartebeest.

The hartebeest is a large African antelope with curved horns. The *common hartebeest, above,* has a reddish-brown coat and a white rump patch. They graze in herds on the African plains.

Hartebeests live in open or lightly wooded areas, where they feed on many kinds of grasses. They run rapidly and can easily outrun a lion or a horse. They travel in herds of 10 to 20 or more. Hartebeests were once found throughout the grassy plains of Africa, but some populations have now become scarce.

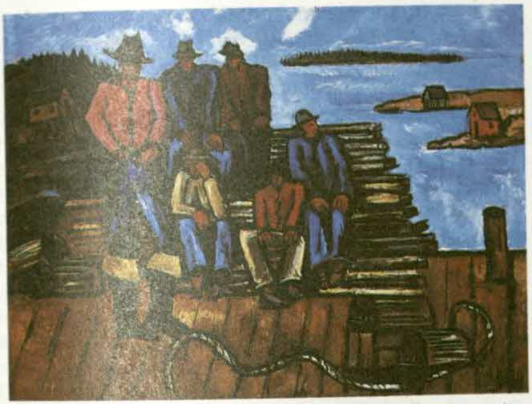
Scientific classification. Hartebeests are in the family Bovidae. The common hartebeest is *Alcelaphus buselaphus.* Lichtenstein's hartebeest is *A. lichtensteinii.*

Hartford (pop. 139,739; met. area pop. 767,841), is the capital and second largest city of Connecticut, U.S.A. Only Bridgeport has more people. About 50 insurance companies have their headquarters in Hartford, which is known as the *Insurance City.* It is also an important manufacturing centre. Hartford lies on the west bank of the Connecticut River, in the north-central part of the state.

Leading industries are the manufacture of aircraft equipment, machinery, electrical equipment, chemicals, precision tools and instruments.

Hartlepool (pop. 88,200) is a local government district and industrial town in Cleveland, England. The town is a seaport and an important supply base for the North Sea oil industry. Other industries include engineering and the manufacture of electronics goods and textiles. The district contains the seaside resort of Seaton Carew. Inland, mixed farming is the main industry. See also **Cleveland.**

Hartley, L. P. (1895-1972), an English novelist and short-story writer, wrote *Eustace and Hilda* (1947), a novel that was awarded the James Tait Black Memorial Prize. His first book, *Night Fears* (1924), was a collection of short stories. His other novels include *The Shrimp and the Anemone* (1944), *The Sixth Heaven* (1946), *The Go-Between (1953), Facial Justice* (1960), *Two for the*



Oil painting on canvas (1941); The Metropolitan Museum of Art, Arthur H. Hearn Fund, New York City

Lobster Fishermen, Corea, Maine is Marsden Hartley's simple but powerful impression of life on the coast of Maine.

River (1961), and *The Brickfield* (1964). Hartley was born near Peterborough, in Cambridgeshire, and named Leslie Poles Hartley. He was educated at Harrow School and at Oxford University.

Hartley, Marsden (1877-1943), was one of the first American painters to experiment with cubism and abstract art. By about 1920 he had returned to a representational style, often using landscape or seashore themes. However, his representational paintings show the influence of his earlier abstract work in their emphasis on pattern and simplification of shapes. Hartley's reputation as a painter came first with his later works. A typical example of this representational style is *Lobster Fishermen, Corea, Maine* (1940-1941).

Hartley was born in Lewiston, Maine, U.S.A. He studied with artist William Merritt Chase in New York and exhibited in the gallery of photographer Alfred Stieglitz, a supporter of pioneering modern artists.

Hartmann von Aue (1170?-1210?) was a German poet. He introduced the legends of King Arthur into German literature by adapting *Erec* and *Yvain,* two romances by the French poet Chrétien de Troyes.

In *Erec,* Hartmann retold the story of an Arthurian hero who gave up knighthood for love. *Yvain* is the story of an Arthurian hero who gave up love for knighthood. *Poor Henry* and *Gregorius* are two original verse epics by Hartmann. They deal with sin and redemption. Hartmann also wrote love poetry and crusade songs.

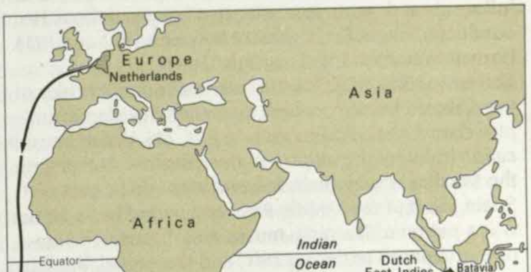
Hartmann was born in Swabia. He was a knight in the service of a Swabian lord.

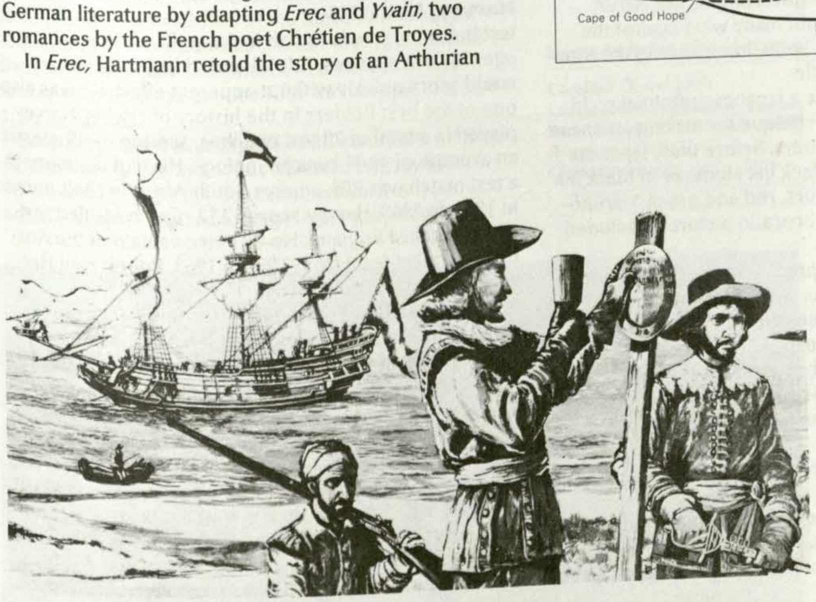
See also **German literature** (Epic poetry).

Hartog, Dirk, a Dutch navigator born in the 1500's, was the first European to land on the western coast of Australia. Hartog was captain of the Dutch ship *Eendracht,* which was sailing to the Dutch East Indies (now Indonesia) to collect spices. The Dutch had established Batavia (now Jakarta) as their chief town there. Hartog landed on the western coast of Australia in 1616. He named the whole western coast region *Eendracht Land.*

In 1611, another Dutch navigator, Hendrik Brouwer, had found a new route to the East Indies. He had sailed southeastward from the Cape of Good Hope, using the

Dirk Hartog, a Dutch navigator, followed a course that used winds called the *Roaring Forties* to travel from the Cape of Good Hope to Java. But he sailed too far east and reached the western shore of Australia instead.





Hartog marked his arrival in Australia in 1616 by attaching an inscribed pewter plate to a post at what is now Dirk Hartog Island. Hartog was the first European to land in western Australia.

westerly winds called the *Roaring Forties* to speed his journey until northerly currents turned his ship toward Java. Hartog followed this route, but sailed too far east. He sighted land near Shark Bay in western Australia in October 1616. With a party from the *Eendracht,* he landed at what is now known as Dirk Hartog Island. While ashore, he fixed an inscribed pewter plate to a post. Another Dutch sailor, William de Vlamingh, found the plate in 1697. Today, it is preserved in a museum at Amsterdam, in the Netherlands. An English translation of the inscription on the plate reads as follows: "On Oct. 25, 1616, there arrived here the ship *Eendracht* of Amsterdam, the supercargo Gillis Miebais of Liege, skipper Dirk Hartog of Amsterdam; on Oct. 27 sailed for Bantam: The subcargo Jan Steyn, the mate Pieter Ledocker Van Bil."

Historians know little of Hartog's life. The only information about him appears in records and maps of the Dutch East India Company (see **Dutch East India Company**).

Harty, Sir Hamilton (1879-1941), was an Irish composer and conductor. His compositions, such as *Comedy Overture,* and his arrangements of Handel's *Water Music* and *Music for the Royal Fireworks* are light in mood and show skilful orchestration. He loved Irish folksongs and wrote fine settings of many of them. He conducted the Hallé Orchestra between 1922 and 1933. Harty was born in Hillsborough, Down.

Harun al-Rashid (766-806) was an important ruler of the Abbasid Dynasty, which governed the Islamic empire during the Middle Ages. In A.D. 786, Harun became *caliph* (ruler) of the empire of the Muslims. At that time, the Muslim empire included northern Africa, part of Spain, most of the Middle East, and part of India. Harun was a patron of learning, music, and the arts. The empire prospered under his rule, and the capital, Baghdad, was a centre of culture as well as wealth. Harun was a leading character in the *Arabian Nights,* a famous collection of Arabic folk tales (see **Arabian Nights**).

Early in Harun's reign, his tutor, Yahya ibn Khalid, and Yahya's sons, controlled the government, but Harun later seized control. He fought many wars against the Christian Byzantine Empire, sometimes leading the Muslim army. Harun died in battle.

Harunobu (1725-1770) was a Japanese printmaker. In 1765, he perfected a new technique for making Japanese woodcut prints in many colours. Before then, Japanese artists had made prints in black ink alone, or in black ink with at most two other colours, red and green. Harunobu's prints, called *nishiki-e* (brocade pictures), included as many as 10 colours.

Harunobu's art has been praised for its great refinement and beauty. Most of his woodcut prints portray delicate, doll-like girls in scenes from everyday life. These scenes reflect an atmosphere of serenity and intimacy. The charm of Harunobu's prints was enhanced by the multicolour printing process. Harunobu's birthplace is unknown, but he spent most of his life in Edo (now Tokyo).

See also **Japanese print** (picture: A tranquil night-time scene).

Harvard University is the oldest institution of higher learning in the United States. It was founded in 1636. The main campus is in Cambridge, Massachusetts. The university also has several schools in Boston, Massachusetts. Harvard University has two major undergraduate divisions—Harvard College and Radcliffe College. Men undergraduates are admitted to Harvard College and women to Radcliffe. All classes are coeducational and the students receive Harvard University degrees.

Harvard's 10 graduate and professional schools are open to both men and women. These schools have over half the university's enrolment. The schools of arts and sciences, design, divinity, education, law, and government are on the Cambridge campus. The schools of business administration, dental medicine, medicine, and public health are in Boston.

Harvard's present educational system was shaped by Charles William Eliot, president of the school from 1869 to 1909. When Eliot came to Harvard, it was a small New England college. When he left, it was a national institution.

Harvest moon is the name given to the full moon that occurs nearest the autumnal equinox of the sun, about September 23. The moon rises at about the same time for several nights. It shines with such brightness that farmers in northern Europe and Canada can work until late at night to take in the autumn harvest. In the Southern Hemisphere, the harvest moon occurs in March, at the vernal equinox.

Harvester. See **Reaper; McCormick, Cyrus Hall.**

Harvesting. See **Agriculture.**

Harvestman is a spider-like animal. Although it has 8 legs, it can be distinguished from true spiders by its long, delicate legs and by its lack of a waist. The body is small, spherical or oval shaped. The two halves of the body are joined by a broad band. When the harvestman walks along, the body is held off the ground.

Harvestmen are active mainly at night and feed mostly on insects, and spiders, as well as on small dead animals. Harvestmen live in temperate regions. In North America, harvestmen are known as *daddy longlegs.*

Scientific classification. Harvestmen form the order *Opiliones* of the class *Arachnida.*

Harvey, Neil (1928-), one of Australia's greatest test batsmen, stands fourth in Australian batting averages for test matches. A left-handed batsman, Harvey could score quickly without apparent effort. He was also one of the best fielders in the history of cricket. Harvey played in a total of 79 test matches, scoring 6,149 runs at an average of 48.41 runs an innings. His highest score in a test match was 205, against South Africa in Melbourne in 1953. In 1948, Harvey scored 112 runs in his first test match, against England. He was vice captain of the Australian cricket team from 1957 to 1963. Robert Neil Harvey was born in Melbourne.

Harvey, William (1578-1657), was an English doctor who discovered how blood circulates in the human body. His discovery became an important foundation of medicine. Harvey's book, *An Anatomical Treatise on the Motion of the Heart and Blood in Animals,* appeared in 1628. It is considered the most important single volume in the history of physiology. He showed that the heart, by repeated contractions, produces a continuous stream of blood that circulates throughout the body and returns to its source (see **Circulatory system; Heart**).

Although his theories were attacked by followers of the ancient Greek doctor Galen, they were based on firsthand observation and experiment. Harvey lived to see his discovery widely accepted, although full credit for it came only after his death.

Harvey was born on April 1, 1578, in Folkestone, England. After graduating from Caius College, Cambridge, he studied medicine at the University of Padua in Italy. He returned to London in 1602 and practised medicine. Harvey became a member of the Royal College of Physicians, and served as physician to James I and Charles I. In 1651, he published his second great work, *Exercitationes de Generatione,* considered the basis for modern embryology. This work deals with reproduction, particularly the part that the egg plays in fertilization.

Harvey, William Henry (1811-1866), an Irish botanist, was a leading authority on algae and seaweeds. He became professor of botany at Trinity College, Dublin, in 1856. Harvey was born in Summerville, Limerick, and went to school in Ballitore, Kildare. In 1831, he discovered a specimen of *Hookeria laeta virens,* a moss not known in Ireland before. He later studied plants in South Africa, the United States, and other countries.

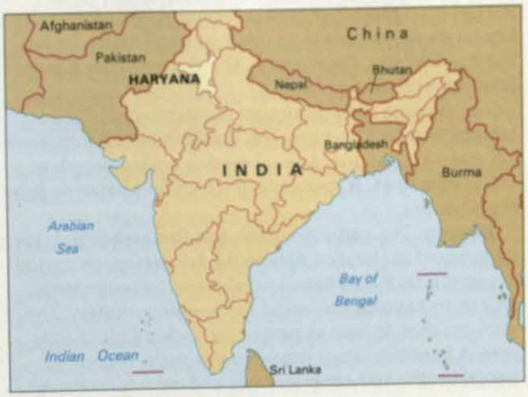
Harwich. See **Tendring.**

Haryana is a state in northern India. In the past, the area has been the site of several crucial battles. The great battle between the Kauravas and Pandavas, recorded in the ancient Hindu epic the *Mahabharata,* occurred at Kurukshetra (see **Mahabharata**). Haryana is now an important agricultural region close to Delhi, the capital city of India.

People and government. About 90 per cent of the population are Hindus, and live mainly in rural areas. Chandigarh, which is a separate territory, serves as the capital of both Haryana and Punjab. There are also several large market towns. The main language spoken is Hindi, but Urdu and Punjabi are also widely spoken.

The president of India appoints a governor of the state for a five-year term. A council of ministers drawn from the legislative assembly aids the governor. Haryana has 90 seats in the legislative assembly. Haryana has 10 elected members in the *Lok Sabha* (lower house) and 5 nominated representatives in the *Rajya Sabha* (upper house) of the Indian national parliament. There are 12 districts, each under the control of a collector. The *panchayat raj* (village council rule) includes all 7,000 villages in Haryana.

Economy. Agriculture is the main economic activity and the state government has invested heavily in farming. It has increased the irrigation network and promoted modern crop technology. Now crops cover 90 per cent of the total area and grain production is increasing rapidly. *Gram* (lentils), mustard, and wheat are the main winter crops. Cotton, maize, rice, and sugar are the main summer crops. Cotton and sugarcane are the main summer crops. Cotton and sugar-processing are important industries. The state also produces high-quality bullocks and dairy cattle.



Haryana is a state in northern India. It lies between the states of Himachal Pradesh, Uttar Pradesh, Rajasthan, and Punjab.

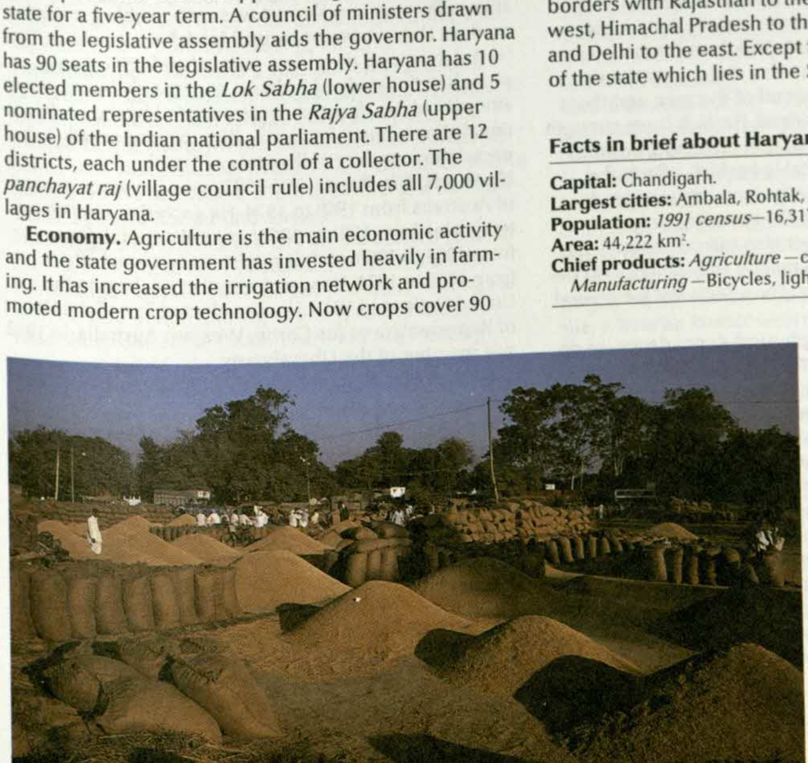
Haryana has no heavy industry but there are light industrial zones in the south. The state is the largest producer of industrial components in India. Other products include bicycles, brassware, cement, glassware, motorbikes, refrigerators, sugar, televisions, tractors, and tyres.

The main towns and cities of the region are on the Grand Trunk Road, the great highway from Lahore to Calcutta. The state has good road and rail services.

Land. Haryana is roughly triangular in shape. It has borders with Rajasthan to the west, Punjab to the northwest, Himachal Pradesh to the north, and Uttar Pradesh and Delhi to the east. Except for a small northern portion of the state which lies in the Siwaliks, Haryana con-

Facts in brief about Haryana

Capital: Chandigarh.
Largest cities: Ambala, Rohtak, Faridabad.
Population: *1991 census*—16,317,715.
Area: 44,222 km^2.
Chief products: *Agriculture*—cotton, rice, sugar, wheat.
Manufacturing—Bicycles, light engineering, paper.



A grain market in Haryana shows how successful the state has been in helping agriculture. Irrigation and improved crop technologies have enabled farmers to grow more wheat, rice, and other grain crops.

sists of level plain. The Jumna (Yamuna) River forms the boundary of Haryana. A number of small rivers, including the Ghaggar, drain into it. The waters of the Jumna feed the irrigation network.

The average daily minimum temperature is 7° C in January and 26° C in June. The maximum is 20° C in January and 39° C in June. Annual rainfall in Chandigarh is 106 centimetres, 90 per cent of which falls between June and October.

History. The earliest settlements that archaeologists have found in Haryana date to the late Harappan period (around 1700 B.C.). These are followed by settlements where archaeologists found ochre colour pottery. The sites are thus known as part of the Ochre Colour Culture. A later important group to live in the region herded cattle and other animals and were farmers. Archaeologists know their settlements from a particular kind of pottery they used known as Painted Grey Ware.

The region was on the receiving end of many invasions from the northwest—the Greeks, the Scythians, the Kushanas, the Huns, the Turks and Afghans, and eventually the Mughals. Some of these ruled the area, particularly the Mughals. In 1857, Haryana leaders played a large part in the revolt against British rule.

The state of Haryana was formed in 1966 from Hindi-speaking parts of the Indian state of Punjab.

See also **Chandigarh; India; Punjab.**

Hashish is a drug that acts on the central nervous system. It is obtained from the hemp plant. It usually produces feelings of contentment and relaxation, but it may make a person sad, nervous, or worried. To a person who takes a large dose of hashish, colours may appear very bright and flowing. Sound and music may seem alive and touchable. Near objects may appear distant, and minutes may seem like hours. In many countries, laws prohibit the possession, sale, or distribution of hashish, except for approved medical research.

Most hashish users smoke the drug in a pipe, but some mix it with food or drink. The drug is most powerful when smoked. The effects also depend on the size and purity of the dose, the mood of the user, and the circumstances in which it is used. Hashish loses strength if it has been stored for a long time. *Tetrahydrocannabinol* (THC), the active chemical in hashish, affects the brain and nervous system. Large amounts may produce *hallucinations,* during which the user sees or hears things that do not exist. A user also may experience *delusions* (false perceptions of reality). In addition, THC decreases muscle coordination. The effects last for several hours.

Hashish does not lead to physical dependence, as do heroin, alcohol, and some other drugs. But some hashish users may become psychologically dependent on the drug and find it hard to stop. They may lose interest in their work, family, or friends.

Hashish and marijuana both come from the hemp plant, but hashish contains from five to eight times as much THC as does marijuana (see **Marijuana**). Hashish is a sticky substance, called a *resin,* that is obtained from the top of the plant. Marijuana is made by drying the leaves and flowering stalks of the plant. Hemp grows in most parts of the world. But most hashish comes from the Middle East and other parts of southern Asia, where it has been used for thousands of years.

Hasidism is a movement in modern Judaism. Followers believe that God is everywhere and that divine light and power touch everything. Therefore, there is no cause for despair or unhappiness. They believe they can best serve God by expressing joy. Hasidism emphasizes joyous prayer. In their religious services, followers sing and dance a great deal. They also express their beliefs through storytelling. Hasidism is organized around spiritual leaders. Each leader heads a local centre. Each has his own way of teaching and living and his own interpretation of the Hasidic tradition.

Baal Shem Tov, a Jewish teacher, and his followers founded Hasidism in Poland and Lithuania about 1760. The movement spread rapidly throughout eastern Europe. By the late 1700's, Hasidic settlements had been established in Palestine. Today, the most important Hasidic centre is Habad Hasidism, located in the borough of Brooklyn in New York City.

See also **Ba'al Shem Tov.**

Haskalah was a movement that tried to modernize traditional Jewish beliefs and practices. *Haskalah* is the Hebrew word for *enlightenment.* The movement began among German and Polish Jews during the late 1700's and spread to other Jewish communities in Europe.

The Haskalah encouraged Jews to dress like non-Jews rather than in traditional Jewish clothing. It called for Jews to adopt the language of the country in which they lived instead of relying on Yiddish, a Jewish language. The Haskalah also urged Jews to enter such fields as agriculture, the arts, and science. The movement believed that Jews should seek a nonreligious education as well as a Jewish education. By following these goals, leaders of the movement hoped to draw Jews into the mainstream of western European culture.

The Haskalah greatly affected Jewish life. The movement revived a spirit of independent learning and creative activity among Jews. It was responsible for starting modern Hebrew literature and Jewish newspapers. The Haskalah helped develop a rational and critical approach to the study of Judaism and its holy books. Many attitudes of the Haskalah were adopted by the Jewish nationalist movement known as Zionism and greatly influenced the founders of the state of Israel.

Hasluck, Sir Paul (1905-1993), was governor general of Australia from 1969 to 1974. He served as minister of territories from 1951 to 1963; as minister of defence from 1964 to 1969; and as minister of external affairs from 1969 to 1974. He was Australian minister to the United Nations in 1946. He was elected first to the House of Representatives for Curtin, Western Australia, in 1949, as a member of the Liberal party.

Hasluck was born at Fremantle, in Western Australia. He was knighted in 1977.

Hassan II (1929-   ) became king of Morocco in 1961. He succeeded his father, King Muhammad V. Under Hassan's leadership, Morocco expanded mining and other industries, irrigated desert land, and built hundreds of schools.

Hassan was born in Rabat. He wrote Morocco's first constitution, which was adopted in 1962. The constitution made the nation a constitutional monarchy governed by the king and a parliament. The parliament blocked Hassan's economic programme, and, in 1965, he took full control of the government's lawmaking and executive powers. Another parliament was elected in 1970. Hassan took full control of the government again in 1972 after Moroccan military leaders tried to assassinate him, but another parliament was elected in 1977. In 1976, Spain gave up its control of Spanish Sahara, an area that borders Morocco to the south. Hassan claimed the area, which is now called Western Sahara, as Moroccan territory. But the Polisario Front, made up of people who live in Western Sahara, opposed Hassan. Fighting broke out between Moroccan and Polisario Front forces and continued into the 1990's. A cease-fire was declared in 1991.

See also **Morocco** (Constitutional monarchy).

Hassanali, Noor (1918-   ), a lawyer, became president of the Republic of Trinidad and Tobago in 1987.

Noor Mohamed Hassanali was born in Trinidad, into a Muslim family. He had his early education in Trinidad. From 1943 to 1947, he studied at the University of Toronto, in Canada, where he obtained a law degree. In 1948, he qualified as a barrister in London, and was admitted to the Trinidad and Tobago bar the same year.

Hassanali worked in private practice from 1948 to 1953, before becoming a magistrate. He served in various government legal posts until 1966, when he was appointed a judge of the High Court of Trinidad and Tobago. From 1978 until he retired in 1985, he was Justice of Appeal of the Supreme Court of Trinidad and Tobago.

Hassett, Lindsay (1913-1993), captained the Australian cricket team from 1948 to 1953. He scored 3,073 runs in 43 Test matches at an average of 46.56 runs an innings. He made his highest score, 198, against India in Adelaide in 1948. In a Test match against England in 1946, Hassett and Don Bradman set an Australian record of 276 runs for a third-wicket partnership. During Hassett's captaincy, Australia lost only 5 Test matches out of 20. For Victoria, he scored 6,935 runs, including 23 centuries, at an average of 63 runs an innings. Arthur Lindsay Hassett was born in Geelong, Victoria.

Hastings (pop. 78,100) is a seaside resort and local government district in East Sussex, England. Hastings was one of the original *Cinque Ports* (five ports; see **Cinque Ports**). The town has two ancient churches. All Saints' was built probably in the 1400's, and St. Clement's dates from the late 1300's. There are ruins of a Norman castle. See also **Rother** and **Sussex.**

Hastings (pop. 57,748) is a city on the eastern coast of the North Island of New Zealand. It is located on the Heretaunga Plains, in Hawkes Bay province. Hastings is in the centre of rich grazing country, where farmers raise sheep and some cattle. There are two freezing works just outside the city. The district is known as *the fruitbowl of New Zealand.* Hastings houses New Zealand's largest canned and frozen foods processing plants. The Hastings district has more than 500 factories.

Hastings was first settled in 1864 on land reclaimed from swamp. It developed after the arrival of the railway in 1873. The city is named after Warren Hastings, the first governor general of India. It has survived two great disasters—a fire in 1883 and an earthquake in 1931.

Hastings, Battle of (Oct. 14, 1066), resulted in the conquest of England by William, Duke of Normandy. Historians rank it among the major battles that changed the course of history.

Harold Godwin became the king of England in 1066, after Edward the Confessor died. But William of Normandy claimed that Edward, his cousin, had promised him the English throne. Harold prepared to defend the coast against an attack, as William enlisted knights from Normandy and northern France. But the king of Norway suddenly invaded northern England to assert his claim to the throne. Harold took his troops north on a forced march. His Anglo-Saxon forces defeated the Norse.

During Harold's absence from the southern coast of England, William landed his army without opposition. Harold hastened south with his weary forces, and gathered such men as he could. He met William's invading troops at the hill of Senlac, near the town of Hastings. Harold almost won a second major victory in three weeks in the day-long battle. His men held the top of the hill. Then the Normans pretended to retreat in disorder, causing the English militia on the flanks to rush down the hill in pursuit. The Norman knights split the English formation, cutting the separate elements of the enemy army to pieces. A Norman arrow killed Harold. But it took William five more years to complete the Norman conquest and end the last resistance to his rule.

See also **Harold** (II); **William** (I, The Conqueror).

Hastings, Warren (1732-1818), was the first governor general of India. He extended British rule in India and improved the courts and tax systems. He also encouraged the study of Indian culture.

Hastings was born in Oxfordshire, England. In 1750, he went to India as a clerk with the East India Company, a British trading company. In 1774, he was appointed governor general. He resigned in 1785 and returned to England. There, political enemies led by dramatist Richard Brinsley Sheridan and statesmen Edmund Burke and Charles James Fox accused him of betraying British ideals of justice and fair play. They impeached him on charges of corruption and misuse of power. After a trial that lasted from 1788 to 1795, Hastings was *acquitted* (declared innocent). But the trial used up all his money and he lived the rest of his life on a pension from the East India Company.

Hat is the name of any of several kinds of coverings for the head. A hat consists of a *crown,* the part that fits on the head; and, in most cases, a circular *brim.* Hats differ from other head coverings, such as bonnets, caps, helmets, and hoods, most of which have a small brim or no brim at all. But the word *hat,* as used in this article, refers to such brimless headgear as well.

Hats vary widely in material and style, depending largely on the climate and people's customs. For example, a Russian farmer wears a snug fur hat to protect himself from the cold. A South American cowboy wears a felt gaucho hat as part of his traditional costume, and the North American cowboy wears a wide-brimmed hat for protection from the sun. The members of a country's armed services wear a different type of hat as part of their uniform. People also wear hats as an accessory to clothing. Thus, fashion often determines hat styles.

Throughout the centuries, the desire of people to be fashionable has resulted in many kinds of unusual hats. During the 1400's, many European women wore a tall, cone-shaped hat called a *hennin.* This hat measured from 1 to 1.2 metres high and had a long, floating veil. The *Gainsborough hat* became popular with both men and women in the late 1700's. It had a wide brim and was decorated with feathers and ribbons.

Why people wear hats. People wear hats for (1) protection, (2) communication, and (3) decoration.

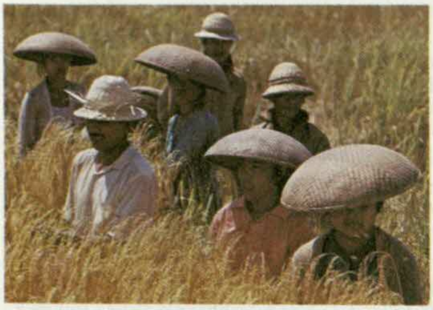
People first began to wear hats to protect themselves from the climate. In hot, sunny climates, wide-brimmed hats provide shade from the sun. Many Mexicans wear such hats, called *sombreros,* which are made of felt or straw. In cold climates, people often wear fur or wool hats. The Lapps of far northern Europe wear tight-fitting wool hats that have earflaps. In some regions, people wear a variety of protective hats, depending on the season. They may wear a fur hat in winter, a rain hat in spring or autumn, and a wide-brimmed hat in summer. Hats also provide protection. For example, building workers, American football players, and military personnel wear metal or plastic helmets for protection from injury.

Hats can communicate various things about the people who wear them. The hats of coal miners, fire fighters, and matadors indicate the wearer's occupation. Students may wear a *mortarboard*—a stiff, flat hat with a

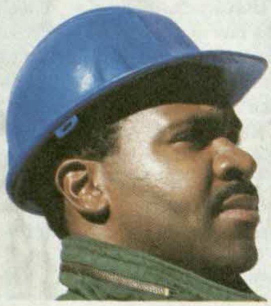
Some kinds of hats worn today

People wear hats for several reasons. Hats may be worn for protection from the climate or from injury. People also wear hats that communicate information about their occupation. Some hats are worn for decoration. The reasons for wearing hats cause much variety in hat styles.

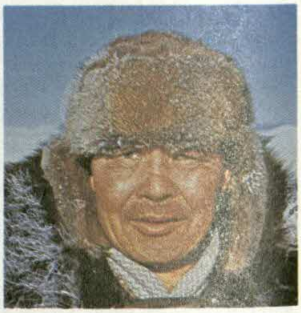
Hats worn for protection



Farmers in Indonesia

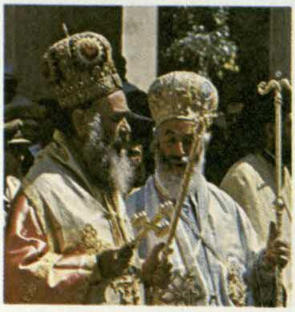


Construction worker

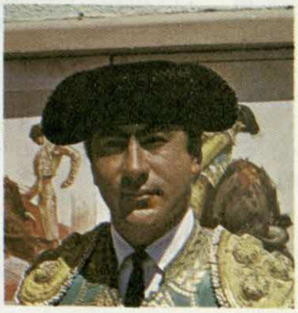


Herdsman in Siberia

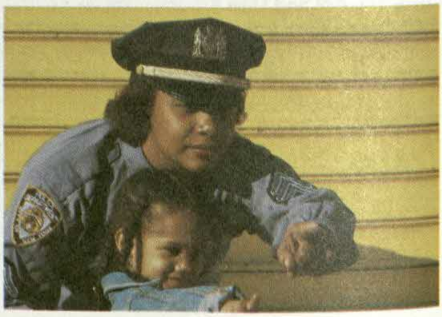
Hats worn for identification



Bishops in Greece

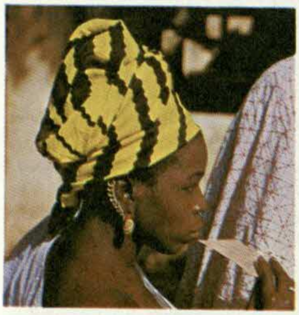


Bullfighter in Mexico

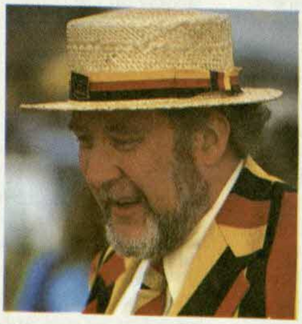


Policewoman in the United States

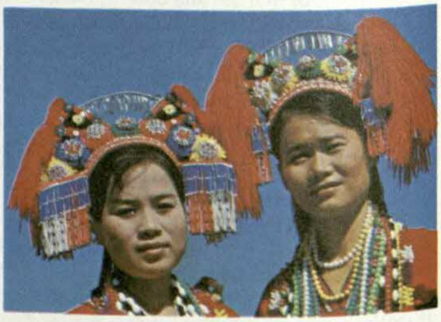
Hats worn for decoration



Woman in Africa



Man in England



Girls in Taiwan

tassel—to show they are graduating from university or college. Many clowns wear colourful, ridiculous hats to express fun and happiness. Among members of the religious group known as the *Amish,* the width of the hat brim and the height of the crown can communicate whether the wearer is married.

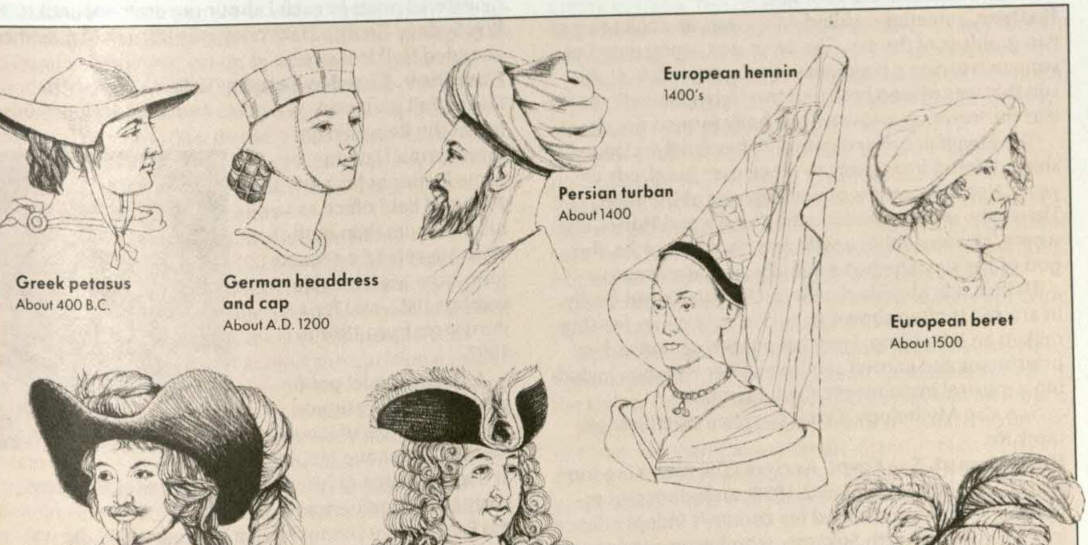
Most people wear a hat that they believe makes them look attractive, though the hat's main purpose may be protection or communication. Much protective headgear, such as fur hoods and rain hats, is both attractive and stylish. Even the caps of police officers and military personnel are designed to improve the wearer's appearance. Certain decorative hats are worn as a tradition. In Scotland, for example, people wear a brimless wool cap with a bobble in the centre called a *tam-o'-shanter* that is part of their national costume.

History. No one knows when people first wore hats. The first coverings for the head were probably worn for protection from the climate. People in various cold climates may have worn fur hoods 100,000 years ago.

Through the centuries, people also wore hats to indicate social status. In ancient Egypt, the nobility wore crowns as early as 3100 B.C. The ancient Greeks and Romans also wore hats to designate status. Some ancient Greeks wore hats called *pelos,* which were usually made from wool fibres. Pelos can still be found in parts of southern Siberia today. They are similar to the brimless, tasselled hat known as a *fez* (see **Fez**).

By the A.D. 1300's, people wore hats increasingly for decoration, resulting in the development of a large variety of hats and frequent changes in styles. People in one area often adopted the hat styles worn in another. Dur-

Some hats of the past Hat styles have varied widely throughout history for several reasons, including changes in fashion and the use of different materials in making headwear. Most hats of the past have gone out of style. But varieties of some hats, such as the beret and the turban, are still worn.



Greek petasus
About 400 B.C.

German headdress and cap
About A.D. 1200

Persian turban
About 1400

European hennin
1400's

European beret
About 1500

European Cavalier hat
1600's

European tricorne
1700's

English Gainsborough hat
Late 1700's

American top hat
1800's

American poke bonnet
1800's

French cloche
1920's

ing the 1300's and 1400's, for example, women in western Europe wore a type of hat that resembled a turban. They first adopted this style from the headgear worn by people who lived in the Middle East and the Orient.

During the 1900's, hat styles varied more widely than ever before. In the 1920's, women wore a drooping, bell-shaped hat called a *cloche.* In the 1930's, they wore the *harlequin hat,* which had a wide, upturned brim. A variety of hats were worn in the 1940's and 1950's. Since the 1960's, hats have been less popular among both women and men.

See also **Clothing** (Traditional costumes); **Derby; Fez; Helmet; Stetson, John B.**

Hathaway, Anne (1556?-1623), was the maiden name of the wife of William Shakespeare. She was born at Shottery, near Stratford-upon-Avon, England. Experts believe that her marriage to Shakespeare took place in 1582. Anne bore the poet three children: Susanna (christened 1583), and the twins Hamnet and Judith (christened 1585). Her cottage at Shottery is kept as a memorial. See **Shakespeare, William.**

Hathor, sometimes called Athyr, was an ancient Egyptian goddess of the sky. She often was represented as a woman wearing a headpiece displaying a disc of the sun that was placed between two horns. Sometimes she was portrayed as a cow whose belly formed the sky.

The Egyptian understanding of her family relationships differed from place to place over hundreds of years. Her main centre of worship was at Dendera. There, she was associated with the sky god Horus. Elsewhere, she was either a wife or a daughter of Re, the god of the sun. She had a son, Ihy, a god of music.

Hathor was identified with the Egyptian royal family. In art, she is often shown as a cow, sometimes feeding milk to an infant king. Egyptian queens served as her priestesses and carried symbols of her worship, including a musical instrument called a *sistrum.*

See also **Mythology** (Other Egyptian divinities; picture); **Re.**

Hatshepsut. See **Egypt, Ancient** (The New Kingdom).

Hatta, Mohammad (1902-1980), an Indonesian nationalist leader, proclaimed his country's independence in 1945, together with Sukarno, who became Indonesia's first president. Hatta served as the country's vice president from 1945 to 1949 and again from 1950 to 1956. He then resigned and retired from politics.

Hatta was born in West Sumatra. His father was a merchant and Muslim scholar. Mohammad Hatta received his early education in Sumatra and Java. In 1921, he went to the Netherlands to study at the Rotterdam School of Economics. He stayed in Europe until 1932, taking an active part in Indonesian nationalist politics as a student. He represented Indonesians at international gatherings. Hatta was one of the first to press for the adoption of the name " Indonesia" for the future, independent homeland. In 1927, he was arrested by the Dutch and imprisoned for nearly six months. But when his case came to trial he was acquitted and released. In 1932, Hatta gained a degree in commerce in Rotterdam. He then returned to Indonesia after an absence of 11 years. He led the Indonesian National Education Party, whose main aim was to train groups of nationalists. In 1934, Hatta was arrested by the Dutch and imprisoned, together with Sutan Sjahrir and other nationalist leaders. When the Japanese occupied Indonesia in 1942, he was released. Hatta became an adviser to the Japanese. On Aug. 18, 1945, he was elected Indonesia's first vice president. In December 1948, when the Dutch conquered Yogyakarta, Hatta was captured and exiled to the island of Bangka. In July 1949, he returned to Yogyakarta. In December 1949, the office of vice president was abolished, and Hatta was elected prime minister. On Dec. 27, 1949, in Amsterdam, Hatta represented the government in accepting the freedom of Indonesia from the Netherlands. In 1950, Hatta ceased to be prime minister and served again as vice president of Indonesia until 1956.

Hatteras, Cape. See **Cape Hatteras.**

Hattersley, Roy (1932-   ), a Labour politician, was deputy leader of the British Labour Party from 1983 to 1992. He had been secretary of state for prices and consumer protection from 1976 to 1979. After the Labour election defeat in 1979, he became the opposition spokesman on home affairs. Hattersley was elected MP for Birmingham, Sparkbrook, in 1964, and held junior ministerial posts in each Labour government until 1976. Roy Sydney George Hattersley was born in Sheffield and attended Hull University.

Haughey, Charles James (1925-   ), an Irish Fianna Fail politician, served as *taoiseach* (prime minister) of the Republic for three terms. Haughey became leader of his party in 1979 and held office as taoiseach from then until 1981. He served a second term from March to November 1982, and for a third term from 1987 to 1992.

Charles Haughey

A controversial politician, Haughey resigned over allegations of involvement in telephone tapping, at the insistence of his party's coalition partners, the Progressive Democrats. In February 1992, he was succeeded by Albert Reynolds.

Haughey was born in Castlebar, County Mayo, and educated in Dublin. He was elected to Dáil Éireann in 1957, and held various ministerial posts between 1961 and 1970. Haughey was minister for health and social welfare from 1977 to 1979.

Hauptmann, Gerhart (1862-1946), a German dramatist, won the Nobel Prize for literature in 1912. Hauptmann's early plays are outstanding examples of naturalistic literature. These early works attempt objectively to portray suffering people whose existence is determined by their environment and by heredity (see **Naturalism**).

Hauptmann was born in Silesia, then a region in eastern Germany. He used the dialect of this region in many of his plays. Hauptmann gained wide acclaim for his naturalistic plays *Before Sunrise* (1889) and *The Weavers* (1893). *The Weavers,* his best-known play, describes the plight of exploited Silesian weavers and their eventual revolt against their employers. His other works include the comedies *The Beaver Coat* (1893) and *The Rats* (1910). He also wrote historical and mythological dramas, plays based on fairy tales, poetry, and prose fiction.

The Hausa have lived in West Africa for more than a thousand years. Most of them live in Niger or Nigeria.

Hausa are a black people of West Africa. There are approximately 7 million Hausa. They make up an important cultural and political group in northern Nigeria and southern Niger. Most of them are Muslims.

The first Hausa settlements were probably built during the 1000's or 1100's. By the 1300's, many Hausa city-states had developed, including Kano, Katsina, Sokoto, and Zaria (see **Nigeria** [political map]). These city-states became important trade centres.

The Songhai Empire controlled the Hausa states throughout much of the 1500's (see **Songhai Empire**). The states then became independent again and, during the 1600's and 1700's, engaged heavily in gold and slave trading. In the early 1800's, local Fulani people who were Muslims led a revolt against the traditional leaders of the city-states. The Fulani and Muslim Hausa rebels conquered many of the city-states and established a Hausa-Fulani empire (see **Fulani**). The British colonized Nigeria in the late 1800's, but the Hausa-Fulani areas remained largely self-governing. Nigeria gained independence in 1960, and the Hausa have since played a major role in Nigerian politics.

See also **Niger** (People; picture); **Nigeria** (People).

Havana (pop. 1,924,886) is the capital, chief port, and largest city of Cuba. It lies on the island's northwest coast. For location, see **Cuba** (political map). About 20 per cent of Cubans live in Havana. Havana's name in Spanish, the language of Cuba, is *La Habana*.

During the first half of the 1900's, Havana was a popular holiday centre. Its lively night life and magnificent beaches attracted many tourists, especially from the United States. But tourism declined after Fidel Castro became prime minister in 1959. He made the country a socialist state. In 1961, the United States broke diplomatic relations with Cuba. The U.S. government severely restricted travel to the country by American citizens. In 1977, the U.S. government ended its restrictions on travel to Cuba, but tourism in the city remains far below its earlier level.

The city of Havana covers about 740 square kilometres. Spanish colonists built Havana in 1519 next to a large natural harbour. Morro Castle, a Spanish fort dating from the late 1500's, guards the harbour entrance.

Old Havana, the colonial part of the city, is west of the harbour. Tile-roofed houses, built in the 1500's and 1600's, line the narrow streets. This historic area includes the famous Havana Cathedral, built in the early 1700's, and the Spanish governor's palace. The former Capitol and many government buildings are in central Havana, west of the old city. Newer residential areas and suburbs lie west of central Havana. The Malecón, a beautiful boulevard, runs along the coast and connects the western residential areas with central Havana.

Education and cultural life. The government controls Havana's schools, and education is free. Many adults attend night school and job-training classes. The University of Havana has about 54,000 students.

Havana's cultural attractions include the government-sponsored National Ballet and the Havana Symphony Orchestra. Museums include the Museum of Fine Arts, which features classical and modern art. The Museum of the Revolution, the Colonial Museum, and the Municipal Museum are historical museums.

Economy. Havana is the commercial and industrial centre of Cuba. The government owns all the nation's businesses and industries. Most of Havana's workers are employed by government agencies or small factories.

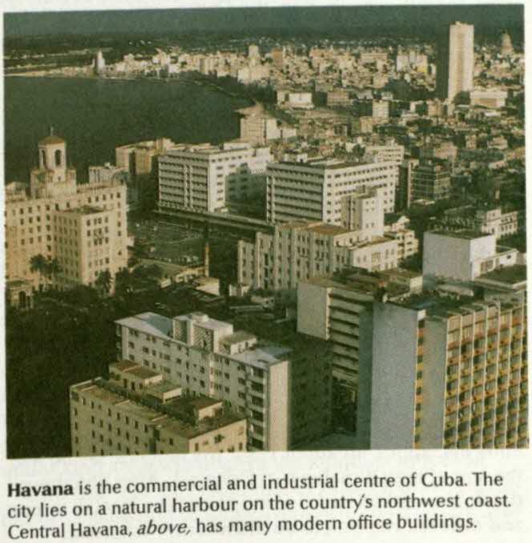
Havana's most important manufacturing activity is the processing of tobacco. Other industries produce beer, chemicals, food products, shoes, and textiles.

About a fifth of Cuba's exports and over half its imports pass through Havana. Exports include canned fruits, fish, and sugar and tobacco products. The main imports include food, machinery, petroleum, and motor vehicles. Cuba trades mostly with Communist countries, but has steadily increased trade with other nations.

An international airport serves Havana. Buses provide most of the transportation within the city.

Government. A Municipal Committee governs Havana. Local workers' groups, made up of members of the Cuban Communist Party, elect committee members.

History. Diego Velázquez, the first Spanish governor of Cuba, founded Havana on the island's south coast in 1515. But the city failed to flourish, probably because of pirate attacks, and was rebuilt on its present site in 1519.



Havana is the commercial and industrial centre of Cuba. The city lies on a natural harbour on the country's northwest coast. Central Havana, *above*, has many modern office buildings.

Havana's location and its harbour attracted many trading ships. The city soon became an important commercial centre. Havana became the capital of Cuba in 1552.

British troops captured the city in 1762 and held it for a year. The British occupation opened up trade between Havana and the British colonies of North America.

In 1898, the United States battleship *Maine* exploded mysteriously in Havana harbour. This event helped bring about the Spanish-American War.

During the first half of the 1900's, the Cuban government spent much money to make Havana a resort centre. American companies invested heavily in Havana businesses. Thousands of visitors from the United States and from other countries poured into Havana. However, many of its people lived in poverty.

Since Castro became prime minister, the Cuban government has invested much of its economic resources in the development of the rural areas rather than Havana and other large cities. As a result, Havana has several serious problems. One of the city's most critical problems is a housing shortage. During the 1960's, the government nationalized many hotels and seized the mansions of people who left Cuba, and converted these dwellings into public housing. The government has also built some new housing.

See also **Cuba; Spanish-American War.**

Havant (pop. 117,400) is a local government district on the coast of Hampshire in southern England. The town of Havant is 108 kilometres from London and faces Langston and Emsworth harbours. The Havant district includes the resort of Hayling Island, which is connected to Havant by a road bridge. See also **Hampshire.**

Havel, Václav (1936-   ), became president of the Czech Republic in 1993. Previously, he was president of Czechoslovakia from 1989 to 1992. He is also an internationally known playwright. Havel's chief goal as Czechoslovakia's president was to guide his country as it changed from Communist rule. This goal included increasing basic freedoms and introducing an economic system based on free enterprise.

Havel was born in Prague. In 1977, he helped found Charter 77, a human rights organization. Because of his work for this organization, the Communist government jailed Havel several times. The government also banned Havel's outspoken plays. In 1989, Havel founded the Civic Forum, a political organization. The Communists lost their control of the government, and the national legislature elected Havel president. In free elections held in 1990, the Civic Forum and an allied party won a majority of seats in the legislature. The new legislature reelected Havel president. At about the same time, a movement grew among Czechoslovaks to split the country into two separate nations, one for each of the country's two main ethnic groups, the Czechs and the Slovaks. In July 1992, Havel, a Czech, failed to receive support for his reelection from the Slovaks in the legislature. Later that month, Havel resigned. On Jan. 1, 1993, the Czech Republic was created. Later in January, the new Czech legislature elected Havel president.

Havelok the Dane was the hero of a group of legends that appeared about 1290. The legends say he was the son of King Birkabeyn of Denmark. After Birkabeyn's death, the wicked Earl Godard seized the Danish throne and ordered Havelok to be drowned. A fisherman named Grim fled with the boy to England, where Havelok is said to have grown much taller than other people. He worked in the kitchen of Earl Godrich. Godrich held England as regent on behalf of his ward Goldborough, daughter of the late King Aethelwold. Godrich wanted the English throne for his own son and forced Goldborough to marry Havelok. Goldborough discovered her husband's royal birth through a vision. Havelok eventually defeated and killed both Godrich and Godard. Afterward, Havelok and Goldborough ruled Denmark and England for 60 years.

Havering (pop. 224,400) is a borough within the Greater London area. It includes the former boroughs of Hornchurch and Romford. Havering was formerly a part of Essex, and lies to the east of London and to the north of the River Thames. The principal town is Romford, which is a regional shopping centre. See also **London.**

Haversian canals are tiny channels within *compact bone tissue,* the hard, outer layers of bone. Each canal contains blood vessels, *lymph* (tissue fluid) vessels, connective tissue, and nerves. The blood vessels carry nourishment from larger vessels in the *periosteum* (membrane covering the bone) to the bone tissue. Layers of bone tissue surround each canal to form a cylinder. A canal and its bone tissue are called an *osteon* or *Haversian system.* Osteons are the basic structures that make up compact bone.

Haw. See **Hawthorn.**

Hawaii is the only state in the United States that does not lie on the mainland of North America. It consists of a chain of 132 islands near the middle of the North Pacific ocean. Hawaii is also the southernmost state. Honolulu, the capital and largest city, is about 3,860 kilometres southwest of the U.S. mainland. About 80 per cent of people live on Oahu, where Honolulu is located.

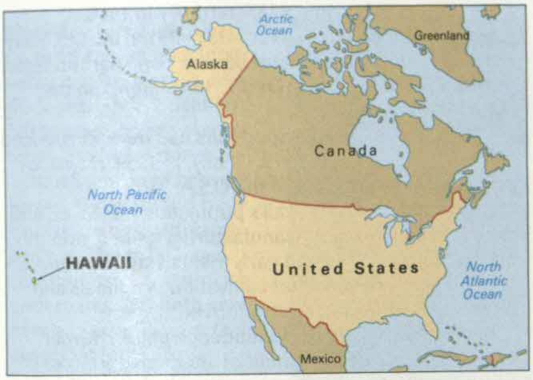
Hawaii is world famous for its beauty and pleasant climate. Its deep-blue seas, brilliantly coloured flowers, graceful palm trees, and magnificent waterfalls provide some of the country's most thrilling scenery.

Some of Hawaii's colourful customs come from Pacific Islanders called *Polynesians,* who were the original settlers of Hawaii. Other customs have been contributed by Hawaiians of Japanese, Filipino, Chinese, Korean, and Samoan ancestry.

Land. Geographers divide the islands into three main groups: (1) eight main islands in the southeast, (2) islets of rock in the middle, and (3) coral and sand islands in the northwest. All the islands were formed by volcanoes built up from the ocean floor.

Facts in brief about Hawaii

Population: *1990 census*—1,115,274.
Area: 16,759 km^2.
Climate: *Average January temperature*—20° C. *Average July temperature—24° C.*
Elevation: *Highest*—Mauna Kea, 4,205 m. *Lowest*—sea level along the coast.
Largest cities: Honolulu, Pearl City.
Chief products: *Agriculture*—sugar cane, pineapples, flowers. *Manufacturing*—food products, printed materials, petroleum products. *Mining*—stone, sand and gravel.
Origin of name: Polynesian chief named *Hawaii-loa,* or *Hawaiki,* legendary name of the Polynesian homeland.
Nickname: Aloha state (Reflects friendliness toward tourists. Aloha is the Hawaiian word for *love*).



Hawaii is an American state which consists of a chain of islands in the North Pacific Ocean.

Most of the eight main islands have white sand beaches. Black sand of powdered lava covers other beaches. Rough, black lava rocks jut out of the water along some of the coasts. In many places, tall cliffs rise almost straight up from the water's edge.

Thick growths of tropical plants and trees thrive in the areas of rich soil where rainfall is heavy. Many of the native plants are found nowhere else in the world. Hawaii has little wildlife, but most of its animals are rare and can be found only on the islands.

The eight main islands, from east to west, are Hawaii, Maui, Kahoolawe, Molokai, Lanai, Oahu, Kauai, and Niihau. Hawaii, often called the *Big Island,* is the largest. Its northeastern and southeastern coasts are rimmed by cliffs. Here and there, silvery waterfalls plunge to the ocean below. Sugar cane is the major crop.

Hawaii Island has the state's only two active volcanoes—Mauna Loa and Kilauea. A highway passes near Kilauea, and the sight of bubbling lava and fire fountains dancing in the crater attracts many visitors.

Maui is often called the *Valley Island.* Many canyons cut into the two volcanic mountains that form the island. Between the mountains is a broad, low isthmus with sugar cane plantations.

Kahoolawe is the smallest of the main islands. It is dry and windswept, and no one lives there.

Molokai is called the *Friendly Island* because of the courtesy its people show to visitors. The island has three regions. Western Molokai is a broad, dry plateau covered mostly by cattle ranches. The eastern region consists of rugged mountains and deep canyons. The central region is a fertile plain where pineapple and other crops are grown.

Lanai, the *Pineapple Island,* has all its cultivated land on one pineapple plantation. Castle & Cooke, Inc., the maker of Dole pineapple products, owns 98 per cent of the island. The rest is owned by the state of Hawaii.

Oahu, the home of about 80 per cent of the state's people, is known as the *Gathering Place.* The island consists of two mountain ranges separated by a wide valley. Pearl Harbor, one of the largest natural harbours in the Pacific Ocean, is on Oahu's southern coast.

Kauai is called the *Garden Island* because of its rich greenery and gardens. The island looks like a circle, with 1,576-metre Kawaikini Peak in the centre.

Niihau is known as the *Forbidden Island.* No one can visit it without the owners' permission. Elizabeth Sinclair bought most of the island from King Kamehameha V in 1864. The Robinson family, descendants of Elizabeth Sinclair, still owns the island. The family runs a cattle ranch that almost covers the island.

Economy. Service industries together account for nearly 30 per cent of Hawaii's *gross state product*—the total value of goods and services produced in a state in a year. No other U.S. state depends so heavily on its income from service industries. Tourism and military activities contribute greatly to the income from the service industries.

Government activities account for more of Hawaii's gross state product than does any other single economic activity. The U.S. Army, Air Force, Navy, and Marines all operate bases on Oahu. Community, social, and personal services form Hawaii's second-ranking service industry, which includes hotels and private health care facilities.

Wholesale and retail trade employs more people than any other industry in Hawaii. Retail trade receives much income from tourists. The wholesale trade of groceries and petroleum products is important in Hawaii.

Property is also a major economic activity in Hawaii. Property values in the state increased steadily because of a rapidly growing population in a small land area.

Food processing is Hawaii's leading manufacturing activity. Refined sugar and canned pineapple are the state's most important food products. Farmers in Hawaii grow almost all of the pineapple and about a third of all the sugar cane in the United States.

Hawaii exports large quantities of flowers and leis. Hilo is the centre of the orchid-growing and flower-packaging industry. Several islands grow macadamia nuts.

Transportation is one of Hawaii's chief problems. Because the state has little manufacturing industry, most goods must be shipped by air or sea from the mainland or from foreign countries. This makes many items more expensive than on the mainland. Travel within the state is expensive because the islands are widely separated. Airlines provide the quickest and easiest way to travel. The chief ports of the islands include Honolulu on Oahu, Hilo and Kawaihae on Hawaii, Nawiliwili and Port Allen on Kauai, and Kahului on Maui.

History. Polynesians sailed to Hawaii in giant canoes from other Pacific islands about 2,000 years ago. Captain James Cook of the British navy landed there on Jan. 18, 1778. Cook traded with the Hawaiians, who considered him a great chief with divine powers.

Many other traders and explorers sailed to the islands after Cook's landing. They brought livestock, manufactured goods, and plants of other countries. During the 1800's, many Hawaiians died of diseases brought from other parts of the world.

Local chiefs ruled the islands during the period of Cook's visits. One chief, Kamehameha, gained control of Hawaii Island in a harsh 10-year war that began in 1782. He later captured and united the other main islands. The local chiefs then served as governors of their islands under King Kamehameha I of the Kingdom of Hawaii.

Between 1811 and 1880, Hawaii shipped great quantities of sandalwood to China. Money from this trade pro-

Polynesian dancers perform at festivals and other events in Hawaii. Polynesians were the original settlers of the islands.

vided a major source of income for Kamehameha I and two later kings of Hawaii.

During the 1800's, hundreds of whaling ships, mostly from the United States, visited Hawaii each year. The sale of supplies to these ships provided the largest income for Hawaiians until the 1860's.

Kamehameha I's son, Liholiho, became King Kamehameha II in 1819. The new king abolished the local Hawaiian religion. In 1820, Protestant missionaries and teachers from the United States converted most of the Hawaiians to Christianity. Roman Catholic missionaries arrived in 1827. But the Hawaiians forced them to leave in 1831, and imprisoned many Catholic Hawaiians. In July 1839, a French ship blockaded Honolulu until the government agreed to free the prisoners and grant religious freedom to Catholics.

From 1854 to 1872, the islands began to be a melting pot of people from various countries. There were not enough Hawaiian workers for the sugar plantations, so the owners brought in labourers from other countries.

King Kalakaua, called the *Merry Monarch,* came to the throne in 1874. During his reign, Hawaiian music, the hula, and many old Hawaiian customs became popular again. They had been prohibited by earlier rulers at the demand of Christian missionaries.

During Kalakaua's reign, sugar-cane planting became a large industry. Sugar planters shipped most of their crop to the United States. The pineapple industry of Hawaii began after a thousand pineapple plants were shipped there from Jamaica in about 1885.

In 1893, a bloodless revolution led by nine Americans, two Britons, and two Germans removed Queen Liliuokalani from the throne. They and their followers formed the Republic of Hawaii. American business executives controlled the government of the new republic. For business reasons, the executives wanted the islands to become a U.S. territory. In 1898, in spite of some Hawaiian opposition, the United States annexed Hawaii as a possession. It became a U.S. territory in 1900.

Shortly before World War I (1914-1918), the U.S. Navy started to build a great naval base at Pearl Harbor. Japan attacked Pearl Harbor on Dec. 7, 1941, plunging the U.S.A. into World War II.

The first of many statehood bills had been introduced in the U.S. Congress in 1919. Finally, in 1959, Hawaii became the youngest state of the U.S.A.

During the 1960's, Hawaii's population increased and the economy boomed. Manufacturing gained strength during the late 1970's and early 1980's. Hawaii's *aquaculture* industry—commercial cultivation of animals and plants that live in water—also thrived.

In order to reduce its dependence on oil, Hawaii looked towards development of alternative sources of energy, including solar energy and wind power.

See also **Honolulu; Kamehameha I.**

Hawaiian goose. See Nene.

Hawaiian honeycreeper is any member of a family of about 20 species of sparrow-sized birds that live only in Hawaii. They get their name from the way honeycreepers *creep* (flutter) about when searching in flowers for insects and nectar.

Originally, there was one species of honeycreeper. The birds wandered to Hawaii or were blown there by a storm. Over time, this species evolved into many species, each with its own feeding habits. Some honeycreepers have a long, curved bill that helps them find food in flowers. Others have a heavy bill for crushing seeds. A third type feeds like a woodpecker, using its strong bill to chisel away tree bark in search of insects.

When Europeans settled in Hawaii in the late 1700's and early 1800's, they brought cats, rats, mosquitoes, and other animals. Some of these animals hunted honeycreepers, and others destroyed much of the forested areas where honeycreepers lived. The mosquitoes carried bird malaria that killed many honeycreepers. About a third of the species of honeycreepers became extinct.

In 1973, two students from the University of Hawaii found a previously unknown species of honeycreeper. This small brown and beige bird was the first bird species discovered in the Hawaiian Islands since 1893.

Scientific classification. Hawaiian honeycreepers make up the subfamily Drepanididae in the finch family, Fringillidae.

Hawdon, Joseph (1812-1871), a farmer, explorer, and politician, pioneered the first overland cattle route to South Australia in 1838. Hawdon was born in Walkerfield, Durham, England. He arrived in Sydney in 1834 and became a farmer near the present site of Dandenong in Victoria.

Hawdon realized the potential market for meat in the struggling colony of South Australia. In January 1838, he and Charles Bonney, another pioneer, set out to drive 300 cattle from the Goulburn River in Victoria along the Murray River to Adelaide. They lost only four cattle. The journey took about 12 weeks. Hawdon discovered and named Lake Victoria and Lake Bonney during the journey.

During the 1840's, Hawdon became a prominent member of the Pastoral and Agricultural Society in Melbourne. Later, he went to New Zealand, where he was nominated to the New Zealand Legislative Council in 1866.

See also **Bonney, Charles.**

Hawfinch is a large finch, up to 18 centimetres long with a big head and a very thick heavy bill. It uses its bill to crack open seeds as tough as cherry stones.

Hawfinches are orange-brown in colour and have blackish wings with large patches. The male has a chestnut head and pinkish underparts, and both sexes have a black patch on their chest that looks like a baby's bib. They are shy birds and spend a lot of time hidden in treetops, feeding on seeds and caterpillars,

Hawfinches are found in most of Europe, North Africa, Asia, and Japan. They live in broadleaf woodland, especially with beech or hornbeam trees.

Scientific classification: The hawfinch belongs to the finch family, Fringillidae. It is *Coccothraustes coccothraustes.*

Hawfinch

Hawk refers to a type of bird of prey. Hawks belong to a large family of birds that includes ospreys, kites, harriers, Old World vultures, and eagles. Hawks live on every continent except Antarctica.

There are two types of hawks, *accipiters,* or true hawks, and *buteo,* or buzzard hawks. Accipiters include such species as the *goshawk* and *sparrowhawk.* These hawks watch and wait for prey from a perch, such as a tree branch. They have relatively short wings and long tails. Buteos generally have longer wings than accipiters and fan-shaped tails, and they frequently soar in search of prey. They include such species as the North American *red-tailed hawk* and the *common black hawk* of Central and South America.

There is also a small group of hawks called *harrier hawks* from Africa and South America. They have double-jointed legs and a knee joint that allows the leg to swing in different directions.

Hawks hunt a wide variety of animals. Their prey can include small mammals, reptiles, fish, insects, and other birds. Hawks that prey chiefly on birds have long, thin toes with sharp, curving *talons* (claws). These "bird hawks" include most accipiters. Hawks that eat mammals and reptiles have stouter legs, shorter toes, and thicker talons than bird hawks. Most buteos belong to this group.

Buteo hawks use their excellent eyesight to spot prey from high up in the air. When a hawk sees its prey, it swoops down and may grasp the animal with its talons. After making a kill, the hawk tears off pieces of the animal with its sharp beak. Some hawks eat bones, feathers, and fur as well as flesh. Because hawks cannot digest everything they eat, they throw up masses of undigested food called *pellets.*

In all species of hawks, the female is larger than the male. Hawks measure from 25 to 70 centimetres in length and weigh from 90 grams to 2 kilograms.

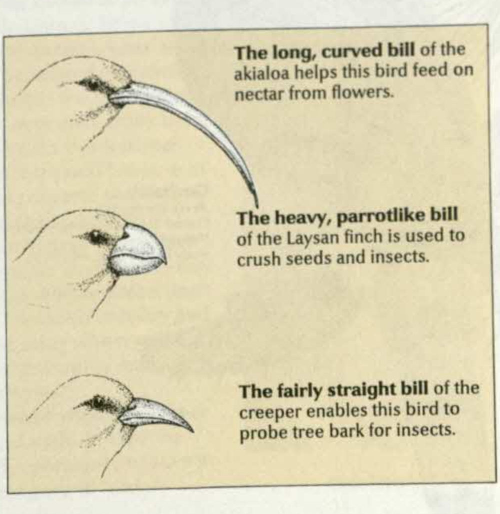
Breeding. Some hawks defend a specific area called a *territory.* The territory may be a nesting place, a hunting ground, or a temporary winter home. Both males and females may defend a nesting area. A hawk defends its territory by attacking or threatening intruders. A hawk may threaten intruders by raising the crest of feathers on its head, by calling loudly, or by repeatedly flying back and forth.

Hawks perform courtship displays to attract mates and to warn away other hawks. At times during courtship, a hawk may fly upward steeply and then suddenly dive downward 30 to 300 metres. A breeding pair may fly together and sometimes "cartwheel" in the air with

The Hawaiian honeycreeper

Hawaiian honeycreepers live only in Hawaii. The apapane, *left,* is one of the most common species. Honeycreepers have three basic kinds of bills, *right,* each suited to a different type of food.

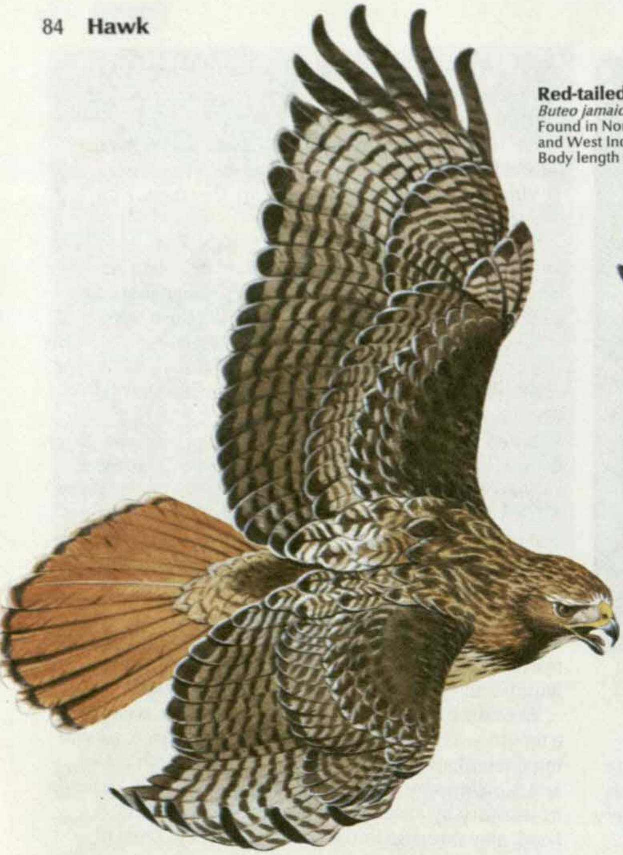
Apapane
Himatione sanguinea
Found in Hawaii
Body length about 13 centimetres



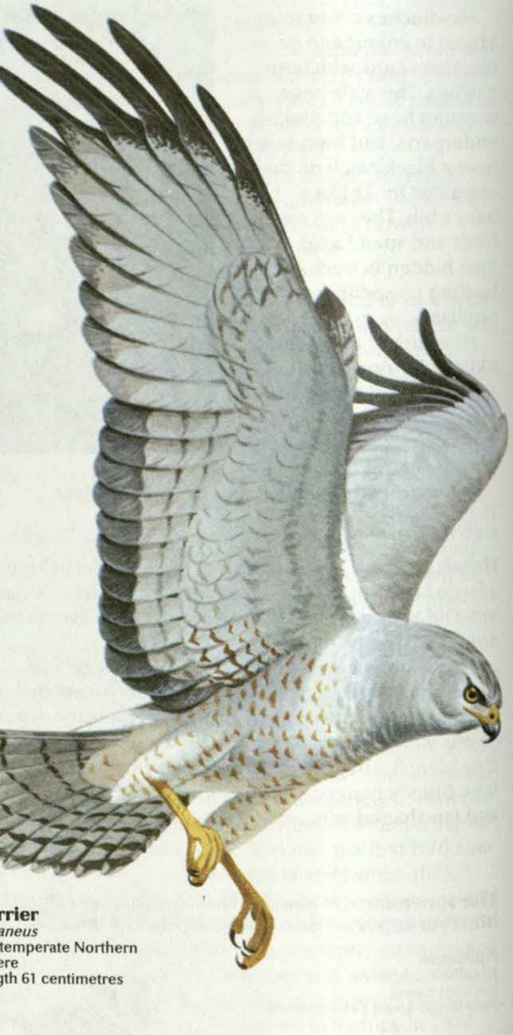
The long, curved bill of the akialoa helps this bird feed on nectar from flowers.

The heavy, parrotlike bill of the Laysan finch is used to crush seeds and insects.

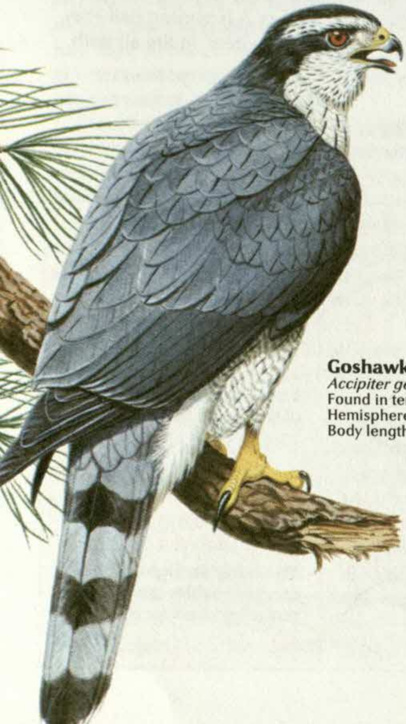
The fairly straight bill of the creeper enables this bird to probe tree bark for insects.



Red-tailed hawk
Buteo jamaicensis
Found in North and Central America
and West Indies
Body length 64 centimetres

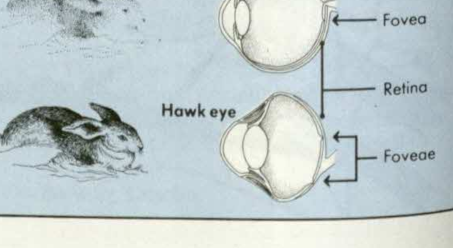


Hen harrier
Circus cyaneus
Found in temperate Northern
Hemisphere
Body length 61 centimetres



Goshawk
Accipiter gentilis
Found in temperate Northern
Hemisphere
Body length 66 centimetres

A hawk's vision is sharper than a human being's. Its eyes have more light-sensitive cells, and most kinds of hawks have more than one *fovea* (an area of the retina). At a great distance, a person sees a rabbit as a blur, but a hawk sees it clearly.



their feet joined together. Some hawks keep the same mate for life.

Hawks nest on cliffs, in trees, or on the ground. Some hawks make a nest by simply scraping away a spot on a cliff. Others build elaborate nests of twigs, grasses, and other plant material. Many hawks occupy the abandoned nests of other birds. Hawks may use the same nests for several years. Females lay from one to three eggs each breeding season. Most hawks *incubate* (sit on and warm) their eggs for about 30 to 35 days before they hatch. The female does most of the incubating while the male provides food. This difference in the roles of the sexes may explain why females are larger than males.

At hatching, young hawks are covered by a thin coat of down. This coat is quickly replaced by a thicker down coat. Eventually, both parents hunt prey for the hatchlings. Struggles for food between two or more young often occur. Young hawks grow rapidly and leave the nest after 30 to 60 days.

Migration. Hawks that live in regions with cold winters migrate to warmer areas for the winter. In some species of hawks, birds of all ages migrate. In other species, most of the younger hawks migrate but the adults do not, and some birds do not migrate every year. Migrating hawks fly during the day and rest at night. Large numbers of hawks of several species may sometimes be seen where migration paths narrow along windy mountain ridges, seacoasts, and lakes. Swainson's hawks have one of the longest migration routes of any hawk. Each year, they fly from Canada and the northern United States to Argentina.

Kinds of hawks. Goshawks are the largest of the true hawks. The female can be up to 60 centimetres long and the male can measure up to 50 centimetres. Many species such as the *northern goshawk* have finely marked plumage. The northern goshawk has grey and white underparts and a whitish streak over the eyes. Goshawks are strong and agile. They prey on birds as large as crows and game birds, as well as on mammals such as squirrels. Other species include the *variable goshawk* of Australia, and the *chanting goshawk* of Africa.

Sparrowhawks have short wings and a long tail. The tail helps to steer them as they pursue their prey at speed through thick woods and forests. See **Sparrowhawk.**

North America has a large number of buzzard-like hawks. Species called "hawks" in North America are known as "buzzard" in the Old World. For example, the rough-legged hawk of North America is known in the Old World as the rough-legged buzzard.

Scientific classification. The red-tailed hawk is *Buteo jamaicensis.* The common black hawk is *Buteogallus anthracinus.* The northern goshawk is *Accipiter gentilis,* the variable goshawk is *A. novaehollandiae* and the chanting goshawks are genus Melierax. The European sparrowhawk is *Accipiter nisus.* The rough-legged hawk is *Buteo lagopus.*

Related articles in ***World Book*** include:

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Harrier
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Marsh hawk
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Vulture

Hawk moth is a member of a worldwide family of large, brightly coloured moths that are also called *sphinx moths.* These moths have powerful, streamlined bodies; long, slender front wings; and small hind wings. They fly quickly and skilfully, hovering in front of flowers and sucking nectar, much like hummingbirds. For this reason they are sometimes called *hummingbird moths.* A hawk moth sips nectar through its *proboscis,* a coiled tube extending from the mouth. The proboscis of one species reaches 25 centimetres in length.

A hawk moth at rest shows its streamlined shape. The underwings have eye spots, which frighten away predators.

The caterpillars often have a sharp horn at the rear end, and are called *hornworms.* When these creatures rest, they raise the front part of their body. In profile, they look like the Egyptian sphinx. They spend their pupal stage in the soil, and do not spin cocoons.

Scientific classification. Hawk moths make up the sphinx moth family, Sphingidae.

See also **Death's-head moth; Moth** (pictures).

Hawke, Bob (1929-), served as prime minister of Australia from 1982 to 1991. An election victory in 1990 made him the first Labor prime minister to win a fourth successive term. But in 1991, during a recession, Labor Party members of Parliament voted to replace Hawke with Paul Keating as head of the party. Keating also replaced Hawke as prime minister. Hawke retired from Parliament in 1992.

As prime minister, Hawke began by trying to reach a *consensus,* a general agreement between business, government, and trade unions, on the direction Australia's economy should take. He also built his approach to the Australian economy on a series of formal agreements, known as *accords,* with the Australian Council of Trade Unions. These agreements produced real restraint on the unions' demands for increased wages during periods of economic difficulty.

During the 1980's, Hawke's government faced a severe economic crisis after Australia's international debt increased because of falling exports and high levels of borrowing. A major feature of the government's economic policy was to remove protection for Australian industry and to do away with regulations governing many local industries.

Hawke worked for freer world trade. In 1989, he took a personal initiative in inviting world leaders

Bob Hawke

to meet in Australia to discuss the formation of an Asian-Pacific economic organization. Hawke also pushed his government into conciliatory roles in foreign affairs matters, notably in finding a solution to the problems of Cambodia. These foreign affairs initiatives took place in an environment of continued ties with the United States, Western Europe, Japan, and Southeast Asia.

Early life. Robert James Lee Hawke was born in Bordertown, South Australia, the son of a church minister. He joined the Australian Labor Party (ALP) at the age of 17. He received degrees in law and economics from the University of Western Australia and attended Oxford University in England on a Rhodes scholarship between 1953 and 1955.

He became an advocate and research officer for the Australian Council of Trade Unions (ACTU) in 1958 and eventually served as its president from Jan. 1, 1970 to Sept. 30, 1980. During his period as president he developed a reputation for solving industrial disputes.

Hawke was elected president of the Australian Labor Party in July 1973 and held the post for five years. He was elected to Australia's House of Representatives in 1980 as the representative of the working class Melbourne electorate of Wills. He became the parliamentary leader of the Australian Labor Party on Feb. 8, 1983. On the same day, the former prime minister Malcolm Fraser called a general election. Fraser lost the election, and Hawke was brought to power.

Hawker, George Charles (1818-1895), a farmer, pioneer, and politician, established a Merino stud, known as *Bungaree*, near Clare in South Australia in 1841. His holdings later expanded to about 28,000 hectares. Experimentation in the breeding of Merino sheep on Hawker's property produced high quality wool.

Hawker was born in London. He landed in Adelaide in 1840. In 1858, he was elected to the South Australian House of Assembly, and he was chosen as its speaker in 1860. From 1875 to 1895, he served as treasurer, chief secretary, and commissioner of works.

Hawker, Harry George (1889-1921), an Australian pioneer in aviation, won fame as a pilot and aircraft engineer during World War I (1914-1918). He founded the Hawker Engineering company, which became part of the Hawker Siddeley group, a leading British aircraft-manufacturing company. Hawker was born in South Brighton (now Moorabbin), Victoria. He learnt to fly in 1912 and soon became a leading test pilot. He was killed in an aeroplane crash near London in 1921.

Hawkes, Jacquetta (1910-   ), an English archaeologist and author, carried out excavations in the United Kingdom, Ireland, France, and Palestine. Her books include *Archaeology of Jersey* (1939), and she was coauthor of *Prehistoric Britain* (1944), *Early Britain* (1945), and *Journey Down a Rainbow* (1955). Jacquetta Hawkes was born in London and educated at Cambridge University. She was vice president of the Council for British Archaeology from 1949 to 1952.

Hawkesbury River is in New South Wales, Australia. Its headstream, the Wollondilly, rises near Goulburn. But the river is officially known as the Hawkesbury from the junction of the Colo and Nepean rivers to its mouth at Broken Bay, north of Sydney.

The area surrounding the Hawkesbury was the main source of grain during the early years of New South Wales. Ships carried goods from Sydney to Broken Bay and then sailed up the Hawkesbury. In 1789, Governor Arthur Phillip named the river after Baron Hawkesbury. In 1794, Lieutenant Governor Francis Grose sent settlers to the area. When Governor Lachlan Macquarie visited the Hawkesbury settlements in 1810, 2,389 people lived there. They lived in clearings carved out of the scrub around Green Hills (now Windsor), on the Hawkesbury River, and on the Nepean River.

On Dec. 6, 1810, Macquarie christened the five towns now known as the *Macquarie Towns*. They are Windsor, Richmond, Castlereagh, Pitt Town, and Wilberforce.

Farmers in the area had been accustomed to living in bark shacks, but Macquarie insisted that houses built in his towns were to be made of either brick or weatherboard, and were to have brick chimneys and shingled roofs. Macquarie encouraged the settlers to seek sanctuary from the frequent Hawkesbury floods by offering them allotments for houses in his new towns. Hawkesbury settlers had suffered in severe floods in 1806. But in spite of this, many refused to take advantage of Macquarie's offer. Those who remained on low ground suffered badly in three severe floods in 1816 and 1817.

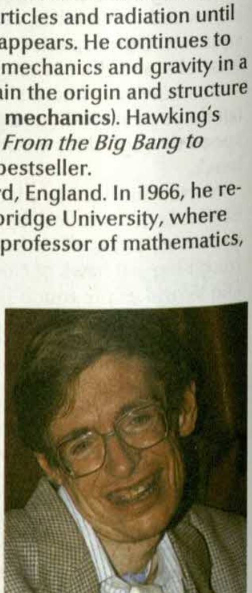
See also **Macquarie, Lachlan; Macquarie Towns.**

Hawking. See Falconry.

Hawking, Stephen William (1942-   ), is a British theoretical physicist. He has made what are generally regarded as the most important discoveries about gravity since physicist Albert Einstein invented general relativity, the modern theory of gravity, in 1915. Hawking's work supports the theory that the universe began 10 billion to 20 billion years ago, in a big bang (see **Cosmology** [The big bang theory]).

Hawking is probably best known for his theories about *black holes*—invisible bodies in space with such strong gravitational force that not even light can escape them (see **Black hole**). Hawking has used the field of physics called *quantum mechanics* to show that a black hole nevertheless gives off particles and radiation until it eventually explodes and disappears. He continues to work on combining quantum mechanics and gravity in a single theory that would explain the origin and structure of the universe (see **Quantum mechanics**). Hawking's book, *A Brief History of Time: From the Big Bang to Black Holes* (1988), became a bestseller.

Hawking was born in Oxford, England. In 1966, he received a doctorate from Cambridge University, where he holds the post of Lucasian professor of mathematics, a post once held by Sir Isaac Newton. Since the early 1960's, Hawking has suffered from amyotrophic lateral sclerosis, also called motor neurone disease, an incurable disease of the nervous system. He became unable to speak or move more than a few hand and face muscles. However, using a wheelchair equipped with a computer voice simulator, he continued to work and travel.



Stephen Hawking

Hawkins, Coleman (1904-1969), was the first important tenor saxophonist in jazz. His full rich tone and superb fluency made him one of the most widely imitated instrumentalists of the 1930's and 1940's.

Hawkins was born in St. Joseph, Missouri, U.S.A. While a teenager, he went to New York City with a jazz group that accompanied blues singer Mamie Smith. From 1923 to 1934, while playing in Fletcher Henderson's orchestra, he gained an international reputation. He was extremely popular in other countries and he moved to Europe in 1934, returning to the United States in 1939.

Hawkins recorded an improvised solo based on the song "Body and Soul" in 1939. It became a best seller and his most memorable performance. After 1940, Hawkins led small groups and toured with the "Jazz at the Philharmonic" concert series.

Hawkins, Sir John (1532-1595), also spelled *Hawkyns,* was an English sea captain during the reign of Queen Elizabeth I. He was a fearless adventurer but also the first English slave trader. In 1568, the Spaniards attacked his fleet in a Mexican harbour. He survived, but the incident added to growing hostility between England and Spain. In 1585, England helped rebels in Holland fight against Spanish rule there, thus provoking war between England and Spain. In 1588, Hawkins helped command the ships that successfully defended England against the Spanish fleet called the Armada. He was knighted in the battle. Hawkins was born in Plymouth, England.

See also Drake, Sir Francis.

Hawks, Howard (1896-1977), was an American film director known for his action films. Hawks also helped create a fast-paced style of comedy called *screwball comedy,* which ridiculed the eccentric or silly behaviour of wealthy characters.

Two of Hawks's finest films deal with World War I (1914-1918). One of them, *The Dawn Patrol* (1930), describes the adventures of fighter pilots in the war. The other, *Sergeant York* (1941), tells the true story of the American soldier Alvin C. York, who became one of the war's most famous heroes. Hawks directed several Westerns, including *Red River* (1948) and *Rio Bravo* (1959). His violent melodrama *Scarface* (1932) became one of Hollywood's most famous gangster films. His film *The Big Sleep* (1946) ranks among the best private detective films ever made. Hawks's most successful comedies were *Twentieth Century* (1934), *Bringing Up Baby* (1938), and *His Girl Friday* (1940).

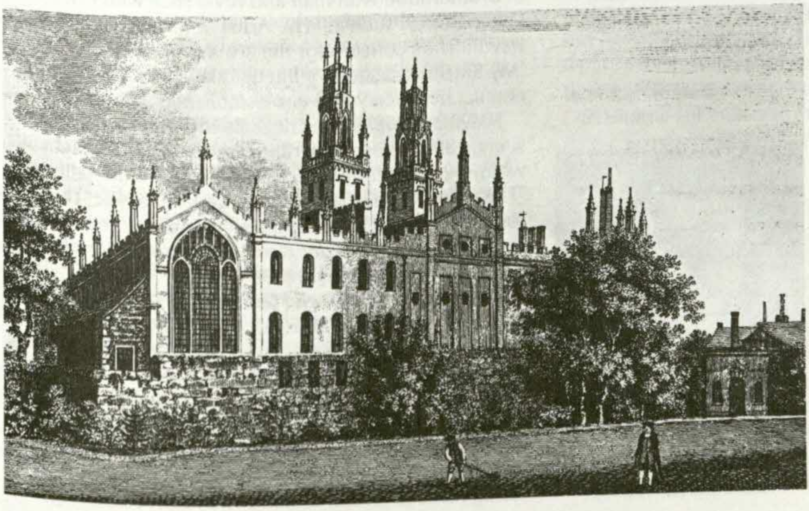
Hawks was born in Goshen, Indiana, U.S.A. He entered the film industry in 1918 as a writer and editor. He directed his first feature film, *The Road to Glory* in 1926. Hawks directed about 40 films.

Hawksmoor, Nicholas (1661-1736), an English architect, designed many of the churches that replaced those destroyed by the Great Fire of London in 1666. His church designs include Christ Church, Spitalfields; St. Mary Woolnoth; and St. George's, Bloomsbury. He also designed the mausoleum at Castle Howard, Yorkshire, and parts of Queen's College and All Souls College, Oxford. Hawksmoor was born at Ragnall, in Nottinghamshire.

Hawkweed is a hairy perennial plant with dandelion-like flowers that may be yellow or orange-red. Hawkweeds have long flower stalks, and strap-shaped leaves that grow out from the bottom of the stem. The European orange-flowered hawkweed grows up to 70 centimetres tall. It has been introduced into Britain and North America. It is sometimes grown as a rockery plant. Hawkweeds generally grow in dry places such as walls, railway banks and mountain ledges.

Hawkweed

Scientific classification. Hawkweeds belong to the daisy family Compositae (Asteraceae), genus *Hieracium.* The orange-flowered hawkweed is *H. aurantiacum.*



All Souls College at Oxford University was designed in part by the architect Nicholas Hawksmoor.

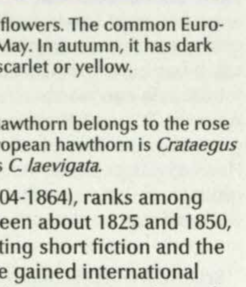
Hawthorn is a thorny shrub or tree with fragrant white, pink, or red flowers. The common European hawthorn is noted for its fragrant blossoms in May. For this reason the hawthorn is sometimes called the *may tree, mayflower,* or simply *may.* The hawthorn is a low, dense tree. The leaves are lobed and vary in size and overall shape, even in trees of the same species. The leaves change to a scarlet or yellow colour in autumn. The fruit, called a *haw,* is fleshy and looks like a small apple. The trunk of a hawthorn tree is deeply furrowed. The wood is hard and strong. There are about 300 species of hawthorns. Some are used as hedging plants and others are planted as ornamental trees.

The hawthorn produces fragrant flowers. The common European hawthorn, *above,* blooms in May. In autumn, it has dark red fruits and its leaves change to scarlet or yellow.

Scientific classification. The hawthorn belongs to the rose family, Rosaceae. The common European hawthorn is *Crataegus monogyna.* The downy hawthorn is *C. laevigata.*

Hawthorne, Nathaniel (1804-1864), ranks among America's major authors. Between about 1825 and 1850, he developed his talent by writing short fiction and the novel *Fanshawe* (1828). Then he gained international fame for his novel *The Scarlet Letter,* a masterpiece of American literature.

Hawthorne's works are noted for their psychological probing into human nature, especially its darker side. Hawthorne set many stories against the sombre background of Puritan New England, the world of his ancestors. Unlike most fiction writers of his time, he was not primarily interested in stirring the reader by sensational or sentimental effects. Hawthorne called his writing *romance,* and defined romance as a method of showing "the depths of our common nature." To Hawthorne, romance meant confronting reality. He often dealt with the themes of morality, sin, and redemption. Among his early influences were the parables and allegories of John Bunyan and Edmund Spenser.



Nathaniel Hawthorne by Charles Osgood. Essex Institute, Salem, Massachusetts

Nathaniel Hawthorne

Life. Nathaniel Hathorne was born in Salem, Massachusetts. He added the "w" to his name when he began publishing. Hawthorne graduated from Bowdoin College in 1825. While attending Bowdoin, he became a friend of future U.S. President Franklin Pierce. After college, he settled in Salem and continued writing. Hawthorne worked in the Boston Custom House in 1839 and 1840 and was a member of the idealistic Brook Farm community near Boston briefly in 1841 (see **Brook Farm**).

Hawthorne married Sophia Peabody in 1842. They moved to the now famous *Old Manse* in Concord, Massachusetts, where Hawthorne continued writing.

Hawthorne was surveyor of customs in the port of Salem from 1846 to 1849. In 1853, President Pierce appointed Hawthorne to a four-year term as United States consul in Liverpool, England. After 1857, Hawthorne lived in Italy and again in England before returning to Concord in 1860. He died on May 18 or 19, 1864, while visiting New Hampshire with Pierce.

His stories and sketches. Between 1825 and 1850, Hawthorne wrote more than 100 tales and sketches for periodicals. Most of these works were collected in *Twice-Told Tales* (1837, 1842, 1851), *Mosses from an Old Manse* (1846), and *The Snow Image and Other Twice-Told Tales* (1851).

The stories and sketches reveal themes central to Hawthorne's imagination. He was haunted by the Puritan society of Massachusetts during the 1600's. To him, the society was represented by his stern forefathers, especially John Hathorne, who was a judge during the Salem witchcraft trials. Hawthorne painted a grim picture of the Puritan past in "Young Goodman Brown," "The Maypole of Merrymount," and other short stories. He was one of the first writers in the United States to re-create the past of his native region. Hawthorne showed the effects of secret guilt in "The Minister's Black Veil" and other stories. In "Wakefield," he described the effects of voluntary isolation from society.

In "The Birthmark," "Ethan Brand," and "Rappaccini's Daughter," three of Hawthorne's finest stories, the central characters suffer from intellectual pride. Hawthorne called such pride "the Unpardonable Sin," describing it as the "sin of an intellect that triumphed over the sense of brotherhood with man and reverence with God." Other stories, such as "The Artist of the Beautiful," show Hawthorne's concern for the artist's role in society. In "My Kinsman, Major Molineux," Hawthorne treated the conflict between youth and established authority.

Hawthorne's sketches deal chiefly with New England scenes of his time. They range in tone from the light whimsy of "A Rill from the Town Pump" to the satire of "The Celestial Railroad" and the dark fantasy of "The Haunted Mind." Hawthorne also wrote two popular children's books, *A Wonder Book for Boys and Girls* (1852) and *Tanglewood Tales* (1853).

His novels. *The Scarlet Letter* (1850) is introduced by "The Custom House," an essay in which Hawthorne sketched the novel's background and his experiences as a customs official while writing the book.

The novel itself is controlled by a single idea—the suffering that results from sin. Hawthorne believed that sin—adultery in *The Scarlet Letter*—results in the isolation of the sinners. Isolation leads to suffering, and suffering leads to further sinning and further suffering. The spiral continues until the sinners either destroy themselves or seek forgiveness and rejoin the community.

The Scarlet Letter is set in Puritan Boston. The plot is formed by the interactions of the adulteress Hester Prynne, the adulterer Arthur Dimmesdale, and Hester's husband, Roger Chillingworth. Hester symbolizes the force of love. Dimmesdale, a minister, represents the spirit, and Chillingworth symbolizes the mind.

Hawthorne shaped his tale in four parts, each dominated by a single force. The force in the first section (chapters 1-8) is the Puritan community; in the second (chapters 9-12) it is Chillingworth; in the third (chapters 13-20) it is Hester; and in the closing part, Dimmesdale. Each section centres on one great dramatic scene in a symbolic setting. The symbolic setting in the first, second, and fourth sections is the scaffold in the Boston market place, on which sinners were exhibited and shamed. The forest with its darkness is the symbol in the third section. Hawthorne expanded and intensified the meaning of the action by pictures of light and dark colours he created verbally and by his quiet, ironic tone.

The House of the Seven Gables (1851) tells the story of a curse placed on the House of Pyncheon by Matthew Maule, a victim of the Salem witchcraft trials. Hawthorne traces the curse's effect on the Pyncheon descendants and describes their final reconciliation to their past.

The Blithedale Romance (1852), a tragic love story, is Hawthorne's closest approach to a novel of observed life. He drew his characters in part from the men and women he had known in the Brook Farm community.

The Marble Faun (1860) is a psychological study of two young American artists in Italy and their relationship with a mysterious woman painter and a young nobleman.

Hay consists of the dried stems and leaves of plants, and serves as feed for cattle, horses, and other animals. Hay is most often made from a *legume,* such as alfalfa or clover, or from a forage grass, such as orchard-grass, smooth brome, or timothy. Hay commonly consists of a mixture of legumes and grasses. In some areas, farmers make hay from wild prairie grasses.

Farmers have traditionally cut hay with a sickle mower and left it on the ground to dry. A machine called a *conditioner* crushed the hay, which reduced the drying time. Farmers then raked the hay into long rows called *windrows* and allowed it to dry further. Today, many farmers use a machine called a *swather* that cuts, conditions, and windrows hay in one operation.

Farmers take great care to dry hay properly before storing it. Hay that contains too much moisture will spoil. In addition, as the damp hay spoils, enough heat may be created to start a fire. A mechanical dryer can speed the drying process. However, mechanical drying is costly, and so it is rarely used.

After the hay has been cut and dried, farmers use special machines to prepare it for storage. Some farmers use baling machines that gather the hay into rectangular bales weighing from 23 to 68 kilograms. The balers then tie the bales with wire or twine. The farmer stacks the bales onto a wagon by hand or by means of automated equipment. The wagon transports the bales to barns or outdoor storage areas.

Other farmers store hay in large round or rectangular bales that weigh from 455 to 910 kilograms. These bales are tied with heavy plastic twine and moved with equipment mounted on a tractor. To keep rectangular bales dry, farmers may cover them with loose hay, plastic, or canvas. Round bales can be stored uncovered because they shed water better.

Hay is harvested with a baler. The baler shown above presses the cut hay into rectangular bales and then ties them with twine.

Machines called *haystackers* compress hay into large loaves that weigh from 910 to 7,300 kilograms. Other machines then unload the loaves in the storage area.

Sometimes, farmers choose to chop the hay before storing it. In this case, a *forage harvester* cuts the hay into short pieces and blows it onto a wagon or truck. Farmers can store chopped hay in barns or process it into small wafers or cubes.

See also **Alfalfa; Horse** (Food); **Rake.**

Hay, Ian (1876-1952), was the pen name of the Scottish novelist, playwright, and soldier Major-General John Hay Beith. He wrote light-hearted novels of charm and humour that became highly popular. The first was *Pip* (1907). During World War I, he wrote *The First Hundred Thousand* (1915), the first of his successful war books. His best-known plays were *Tilly of Bloomsbury* (1919) and *Housemaster* (1936). Hay was born in Manchester and educated in Edinburgh and at Cambridge.

Hay fever is an allergy that occurs most frequently during the spring, summer, and autumn. Grasses, trees, and weeds produce pollen during those seasons, and hay fever sufferers are allergic to pollen. Airborne fungi and moulds can also cause the allergy in some persons or even increase the seriousness of its symptoms. Like most allergies, hay fever runs in families. A person can develop the allergy at any age. The medical name for hay fever is *pollinosis.* See **Allergy.**

Symptoms of hay fever include runny, red, and itching eyes and a runny, blocked nose. The nose may also itch and swell. Hay fever victims have repeated periods of sneezing and may temporarily lose their sense of smell. A victim's ears may be blocked as well.

About a third of those who suffer from hay fever develop seasonal asthma. Hay fever also may result in *sinusitis,* a sinus infection. In addition, it may cause the development of infection or of growths called *polyps* in the mucous membrane. See **Asthma; Sinus.**

Treatment. Hay fever has the same symptoms as a year-round condition called *perennial allergic rhinitis.* A doctor performs tests to identify the causes of a patient's allergy. If the person has hay fever, the doctor performs tests to discover which pollen, fungus, or mould caused it. Most persons with allergic rhinitis are sensitive to any kind of dust—especially house dust—and to some foods and even to animal dandruff.

Most doctors prescribe drugs called *antihistamines,* which provide quick relief for some sufferers. These drugs should be taken only under a doctor's supervision because they cause dangerous side effects in some people. Other drugs lessen the swelling of the membranes lining the nose and reduce the running of the nose.

If a patient is extremely sensitive to pollen, the doctor may prescribe *hyposensitization.* This treatment involves injecting pollen extract into the patient's body at regular intervals, slowly increasing the strength of the concentration of the extract. The injections cause the body to form antibodies to help fight the allergic reaction.

Hay-Pauncefote Treaty enabled the United States to build the Panama Canal. It was signed by the United States and Great Britain in 1901. The treaty gave the United States the sole right to build or supervise the construction of a canal across the Central American isthmus, as well as the right to manage it. All nations were to pay fair and equal traffic charges and enjoy equal rights during peacetime. In wartime, the U.S. could close the canal to any nation. Great Britain admitted that the United States also had the right to fortify and defend the canal. The treaty was named after its negotiators—U.S. Secretary of State John Milton Hay and British ambassador to the United States Sir Julian Pauncefote. See also **Panama Canal; Clayton-Bulwer Treaty; Treaty** (picture).

Hayam Wuruk (1334?-1389), also known as *Rajasanagara,* ruled the Javanese state of Majapahit from 1350 to 1389. He succeeded his mother, Queen Tribhuwana. Hayam Wuruk's reign was the golden age of Majapahit. Under him, the state of Majapahit conquered new territory and reached a level of civilization never seen before. It achieved economic prosperity in agriculture because of an extensive irrigation system, regulated by inspectors. In commerce, the port of Tuban became the chief harbour of the Indonesian islands. Under Hayam Wuruk's rule justice was administered strictly. Even minor offences were punished by death. But offenders who could hide themselves for three days after an offence had been committed were allowed to go free. Fine temples were built.

See also **Gajah Mada** and **Majapahit.**

Hayden, Melissa (1923-), is a Canadian-born ballerina. She gained international fame as a principal dancer with the New York City Ballet under its artistic director, George Balanchine. He created several ballets for Hayden, including *Agon* (1957) and *A Midsummer Night's Dream* (1962).

Hayden was born in Toronto. Her real name was Mildred Herman. Hayden danced with the New York City Ballet from 1950 until she retired in 1973. She also performed with the Ballet Theatre (now the American Ballet Theatre) from 1945 to 1947 and in 1953 and 1954. After her retirement, she became a ballet teacher, director, and coach. She has written two books: *Melissa Hayden, Off Stage and On* (1963) and *Dancer to Dancer: Advice for Today's Dancer* (1981).

See also **Ballet** (pictures).

Bill Hayden

Hayden, William George (1933-), became governor general of Australia in 1988. He was leader of the Australian Labor Party in the federal Parliament from 1977 to 1983. He resigned in 1983 and Bob Hawke assumed leadership of the party. Hayden was born in Brisbane and educated at Brisbane State High School. After leaving school at age 16, he worked for four years in the Queensland public service. He was a police officer in Queensland from 1953 to 1961. In 1961, he was elected to the federal Parliament for the seat of Oxley in Queensland. He completed an Economics degree at the University of Queensland in 1968. He was minister for social security from December 1972 to June 1975, and treasurer from June 1975 to November 1975. As minister for social security, he was responsible for the establishment of Medibank, the health insurance system.

Haydn, Joseph (1732-1809), an Austrian composer, ranks among the most important persons in the development of instrumental music. He has been called the father of the symphony. Haydn did not write the first symphonies. However, he developed the symphony from a short, simple form of musical composition to a long form for large orchestra. The combination of instruments that he used in his symphonies became the basis of today's symphony orchestra.

Haydn composed more than 100 symphonies. Most of his later ones consist of four *movements* (sections)—fast, slow, minuet, fast. The first movement may have a slow, noble-sounding introduction.

Haydn wrote more than 80 *string quartets* (compositions for two violins, a viola, and a cello). The first violin dominates most of his early quartets, and the other instruments accompany. In his later quartets, Haydn gave the instruments greater equality, and the music suggests a lively conversation among four people. Many of Haydn's quartets are still popular and have acquired nicknames. These quartets include "The Bird" (1781), "Sunrise" (1799?), and "Emperor" (1799?).

Haydn wrote operas and other works for voices. Two *oratorios* (compositions for soloists, large chorus, and orchestra) rank among his greatest works. They are *The Creation* (1798) and *The Seasons* (1801).

Haydn was born Franz Joseph Haydn in Rohrau, an Austrian village near Vienna. A family friend noticed Haydn's pleasant voice and helped him gain admission to the boarding school at the emperor's court in Vienna in 1740. Singers were trained for the Court Chapel at the school. However, Haydn was dismissed from the choir school in 1749 after his voice broke.

Many difficult years followed for the young musician. Finally, in 1761, Haydn went to work at the court of Prince Esterhazy in eastern Austria. He was soon put in charge of all music at the court and remained there for about 30 years. The prince was fond of music, and Haydn was kept busy composing works for him.

Haydn met the composer Wolfgang Mozart in 1781.

The two remained close friends until Mozart's death in 1791. Haydn acknowledged Mozart's superiority as a writer of operas, and Mozart admitted he learned much from Haydn about composing instrumental music.

Haydn visited England in 1791 and 1794. He wrote his last 12 symphonies (numbers 93 to 104) there. Generally called the "London" Symphonies, they include the famous "Surprise" Symphony (number 94). Haydn spent his last years in Vienna.

Hayes, Helen (1900-1993), was an American actress. Many critics consider the role of Queen Victoria in the play *Victoria Regina* (1935) her greatest success. Hayes won the 1931-1932 Academy Award as best actress for her performance in *The Sin of Madelon Claudet,* which was her first film. She received the 1970 Academy Award as best supporting actress for her performance in *Airport.*

Hayes made her stage debut in 1905. Her performance in Sir James Barrie's play *Dear Brutus* in 1918 made her a star. She retired from the stage in 1971, although she continued to act occasionally in films and on television.

Helen Hayes Brown was born in Washington, D.C. In 1928, she married playwright Charles MacArthur. Hayes wrote about her life in *On Reflection* (1968) and *My Life in Three Acts* (1990).

Hayes, Rutherford Birchard (1822-1893), was president of the United States from 1877 to 1881. A Republican, he was elected president in 1876 by a margin of only one electoral vote. Congress had to create a special Electoral Commission to decide the winner.

When Hayes became president, the problem of Reconstruction in the South still divided the American people, even though the American Civil War had ended 12 years earlier. Hayes had promised to end Reconstruction and he did. Within two months after he took office, the last federal troops marched from the South. Hayes was born in Delaware, Ohio, U.S.A.

Hayman Island is a popular Australian tourist resort. The island lies 50 kilometres northeast of Proserpine and 29 kilometres from the coast of northern Queensland. It is in the Whitsunday group of islands, near the Great Barrier Reef. It contains 384 hectares of trees and bird life. The tourist industry, with luxurious tropical accommodation, caters for people who enjoy water sports, fishing, and entertainment. A main attraction is the colourful coral that appears at low tide on the western and southern sides of the island. Fish in the area include mackerel, coral cod, and kingfish.

Haynes, Elwood (1857-1925), a pioneer American car inventor and manufacturer, designed one of the first successful cars. The vehicle was built for him by Elmer and Edgar Apperson in Kokomo, Indiana, and was first driven on July 4, 1894. It is now on exhibition in the Smithsonian Institution.

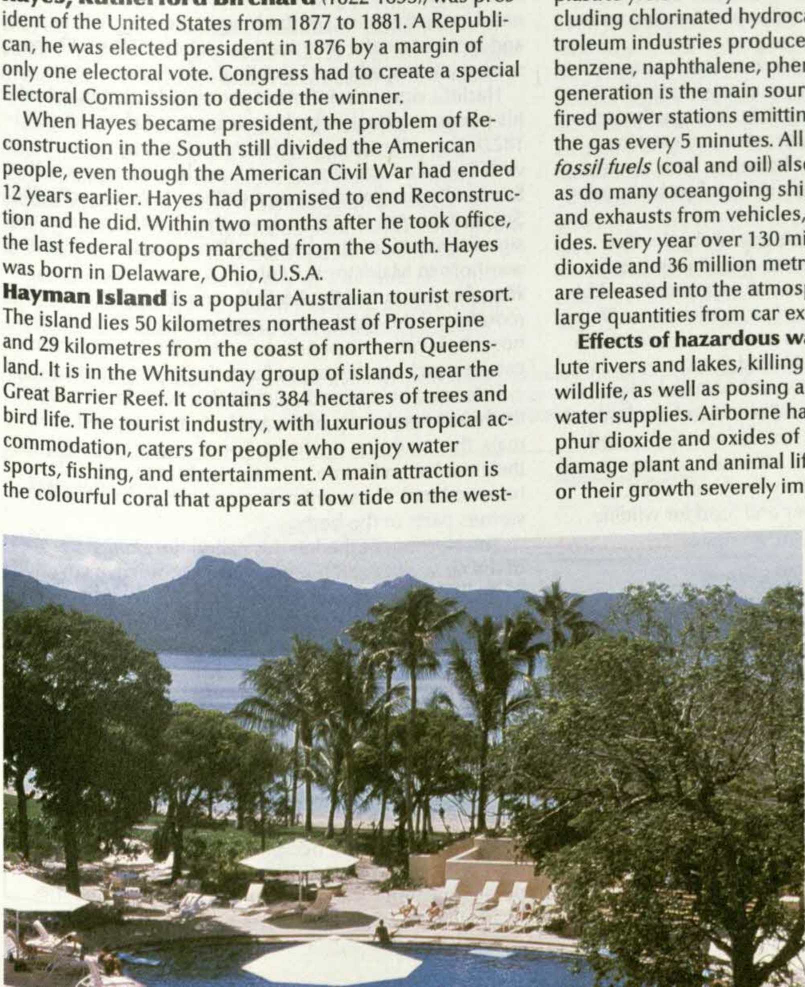
His inventions included carburettors and exhausts, which improved early cars. As a metallurgist, he created various alloys. His best-known alloy is a cobalt alloy called *Stellite.* It is used in metalworking tools because it retains a good cutting edge. Haynes was born in Portland, Indiana.

Hazardous wastes are unwanted chemicals and their by-products produced by society which may endanger human health, or pollute the environment. Every year, about 375 million metric tons of hazardous wastes are produced, 90 per cent of them in industrialized countries.

Some of the commonest hazardous wastes are arsenic, cyanide, lead, and mercury and their compounds, chlorinated solvents, asbestos, and organochlorine pesticides. Also, burning produces oxides of sulphur and nitrogen, which are hazardous at high concentrations.

Producers of hazardous wastes. The production of plastics yields many harmful organic compounds including chlorinated hydrocarbons, and the oil and petroleum industries produce toxic substances such as benzene, naphthalene, phenol, and ammonia. Electricity generation is the main source of sulphur dioxide, coal-fired power stations emitting as much as 1 metric ton of the gas every 5 minutes. All other industries which burn *fossil fuels* (coal and oil) also produce sulphur dioxide, as do many oceangoing ships. All burning processes, and exhausts from vehicles, also produce nitrogen oxides. Every year over 130 million metric tons of sulphur dioxide and 36 million metric tons of nitrogen oxides are released into the atmosphere. Lead is produced in large quantities from car exhausts.

Effects of hazardous wastes. Hazardous wastes pollute rivers and lakes, killing fish, water plants and other wildlife, as well as posing a danger to city and industrial water supplies. Airborne harmful wastes, such as sulphur dioxide and oxides of nitrogen, pollute the air and damage plant and animal life. Plants are killed outright, or their growth severely impaired, and animals suffer



Hayman Island is a holiday resort off the coast of Queensland, Australia. Tourists can visit the Great Barrier Reef all year round.

respiratory problems if they breathe in these chemicals. Sulphur dioxide and nitrogen oxides react in the atmosphere to form sulphuric and nitric acids. These chemicals dissolve into rain as it falls, creating acid rain. Acid rain in turn removes nutrients from the soil and damages tree growth. See **Acid rain.**

Harmful chemicals also pollute ground water, sometimes contaminating drinking water. Lead is a nerve toxin and can affect the development of a child's brain. Asbestos can cause a respiratory disease known as asbestosis, as well as chest and lung cancer. Mercury is a highly toxic chemical which attacks the nervous system, causing brain damage, and even death. Arsenic is another chemical that has been shown to cause cancer.

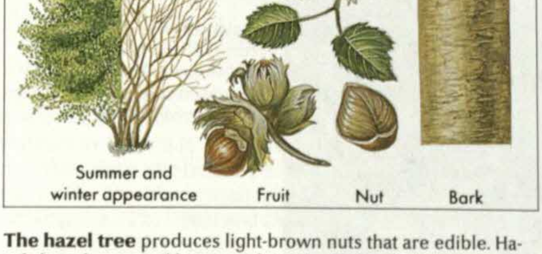
Disposal of hazardous wastes. As hazardous wastes pose such a severe threat to public health and to the environment, they should be disposed of with care and forethought. Unfortunately, this is not always done. Many accidents have occurred involving the escape of toxic chemicals. Another problem is that large quantities were buried many years ago, without adequate thought about the future risk. The commonest method of disposal is to bury the waste in landfills. These should be lined with a non-porous substance, like clay, and be sited so as to prevent chemicals from seeping out into the ground water or from contaminating surrounding land. Another method of disposal involves pumping wastes into deep wells designed to prevent contamination of ground water.

Some industries recycle their hazardous wastes or use the wastes of other industries as raw materials. Another disposal method involves the use of particular types of bacteria. The bacteria break down certain wastes, producing harmless substances. Some hazardous organic compounds are made harmless by burning them at high temperatures.

Hazel is any one of about 15 trees and shrubs that grow in the temperate climates of Asia, Europe, and North America. Hazel is often called *cob,* and the edible nuts it produces are called *hazelnuts, cobnuts,* or *filberts.* Most hazels cultivated for nuts grow in southern Europe and the northwestern United States.

Hazels have large, oval leaves with toothed edges. They turn yellow in the autumn. The plants bear both male and female flowers. The male flowers are naked catkins (see **Catkin**). The female blossoms, borne on separate twigs, are so small that they are hard to see.

Hazels furnish valuable cover and food for wildlife. People also plant them as ornamentals or to shelter other plants. However, in some forests hazels form such dense thickets that tree seedlings cannot grow.



The hazel tree produces light-brown nuts that are edible. Hazels have large, oval leaves with toothed edges. Their strong, flexible branches are used to make baskets and similar objects.

Although hazels are small, their branches are strong and flexible. People use them to make baskets, whip handles, hoops, and many similar articles.

In ancient times many people believed that a forked hazel twig had supernatural powers. Stories tell how *divining rods* of hazel can be used to find water or minerals underground. *Witch* hazel does not belong to the group of true hazels. But it, too, was supposed by the ancients to have many magic powers. See **Witch hazel.**

Scientific classification. Hazels belong to the birch family, Betulaceae. The common hazel of Europe is *Corylus avellana.*

Hazlitt, William (1778-1830), was one of the best essayists and critics in English literature. His critical essays were sensitive and analytical. They were marked by enthusiasm and the pure enjoyment that Hazlitt felt in describing the effect of a literary work. He discussed poets, dramatists, essayists, and novelists of his own and earlier times. His essays were collected in *Characters of Shakespeare's Plays* (1817), *English Poets* (1818-1819), *English Comic Writers* (1819), and *A View of the English Stage* (1818-1821). See **Essay** (Formal essays).

The cornerstone of Hazlitt's thinking and writing was his belief in the human imagination's ability to promote moral behaviour. Hazlitt emphasized the "disinterestedness" (or selflessness) of the imagination. His writings and lectures on the imagination and on William Shakespeare influenced poet John Keats.

Hazlitt's vigorous, informal prose style distinguished his personal essays, which appeared in *Table Talk* (1821-1822). The collection includes "My First Acquaintance with Poets," which describes his early encounters with Samuel Taylor Coleridge and William Wordsworth. *The Spirit of the Age* (1825) analyses the character and social significance of leading personalities of his time. Hazlitt was born in Maidstone, Kent.

Head is the part of the body that contains the brain, the mouth, and the chief sense organs—the eyes, ears, and nose. Its location depends on where the sense organs can best pick up messages from the environment.

In human beings and animals that walk on two legs, the head is at the top of the body. In four-legged animals, the head is at the front. Some organisms, such as the amoeba, and some animals, such as the starfish, have no head. These animals are sensitive to stimuli in various parts of the body.

The skeleton of the head is called the *skull.* It consists of the *facial area* and the *cranium,* a protective covering of the brain. The skull is usually composed of bone. In some animals, such as the shark, it is made of cartilage (see **Cartilage**). The skin that covers the top and back of the head is called the *scalp.*

A system of muscles and tendons joins the head to the spinal column, the collarbone, and the shoulder blades. These muscles and tendons control the movement of the head. The *occipital bone* forms the back of the skull. It rests on the spinal column and forms a joint on which the head moves. Most of the weight of the head is in front of the occipital bone, and the head is held in an erect position by muscles in the neck. When a person becomes sleepy, these muscles relax and the head falls forward. Other large bones of the head in clude the *parietal, frontal, sphenoid,* and *temporal.*

Muscles in the head play an important part in the processes of chewing and swallowing. They are also responsible for facial expressions such as smiling or frowning. Repeated activity of the facial muscles, the gradual loss of fat pads under the skin, and the loss of skin elasticity cause wrinkles to form in old age.

At birth, the head is extremely large in relation to the rest of the body. It measures about a quarter of the total body length. By adulthood, it is only about an eighth of the body length. The size and shape of the head vary from person to person. The normal cranial capacity is about 1,400 cubic centimetres. A larger cranium does not necessarily mean greater intelligence.

Related articles in *World Book.* See the Trans-Vision three-dimensional picture with **Human body.** See also:

Brain
Ear
Eye
Face
Mandible
Mouth
Nose
Phrenology
Sinus
Skull
Tongue

Head, Bessie (1937-1986), was a South African writer. Her novels reflect the struggle of black women in South Africa and her sense of alienation in Botswana, where she lived in exile from 1963.

Head's first novels were *When Rain Clouds Gather* (1969), and *Maru* (1971). *When Rain Clouds Gather* portrays the ideal village community in which the ordinary person matters. *A Question of Power* (1974) is largely autobiographical and tells the story of a young woman who experiences a mental breakdown. Other works include *The Collector of Treasures* (1977), *Serowe: Village of the Rain Wind* (1981), and *A Bewitched Crossroads: An African Saga* (1984).

Bessie Amelia Head was born in Pietermaritzburg, South Africa, of mixed parentage. She worked as a teacher and a journalist before becoming a writer.

Headache is one of the most common ailments among human beings. Headache pain varies from mild to severe and may last less than an hour or for days.

Headaches are caused by any of a number of conditions. A head injury, tense head muscles, or throbbing arteries in the scalp can cause a headache. Eye strain, fever, sinus infection, or an allergic reaction can also lead to headache. In relatively few cases, headaches are related to a brain tumour or some other brain disease.

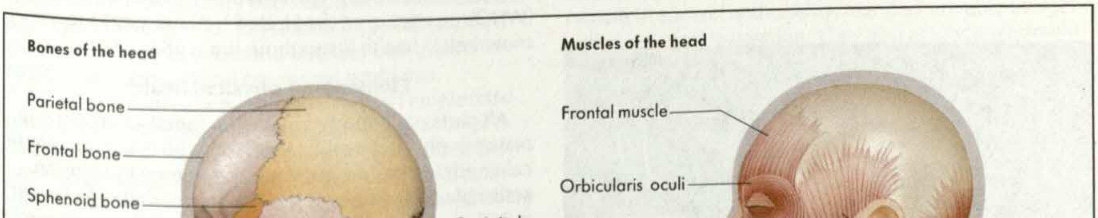
There are two main kinds of headache, *acute* and *chronic.* Acute headaches occur infrequently and most of them last only a short time. Most people have acute headaches occasionally, but few seek a doctor's advice because the pain does not persist. In most cases, rest and nonprescription drugs relieve the person's discomfort. Chronic headaches occur frequently and may last several days. They may be continuous. Two of the most common types of chronic headache are *migraine* and *tension headache.* People with chronic headache should seek medical attention.

Migraine is one of the severest types of headache. It is also called *sick headache* because the pain may be accompanied by nausea and vomiting. Migraine may be caused by increased stretching, swelling, and throbbing of the arteries and veins lining the brain and outside the skull. Some scientists believe the *fifth cranial nerve,* also called the *trigeminal nerve,* plays a role in migraine. This nerve extends from the base of the brain to the face, sinuses, eyes, and teeth. Such foods as chocolate and various strong cheeses may trigger migraines.

Migraine recurs from time to time and is often so painful that the victim must stay in bed. Some people suffer migraines as frequently as two or three times a week. In other cases, attacks occur several months or even years apart. For many sufferers, each migraine attack follows the same pattern. Before the pain begins, they may see flashing lights or have a blind spot in their field of vision. The pain usually strikes on one side of the head, and nausea and vomiting may follow. Some victims also shed tears, experience blurred vision, or have numbness in an arm or leg.

Doctors prescribe various drugs to help lessen the swelling of the arteries in the head during a migraine attack. Some migraine patients practise *biofeedback,* a method of controlling normally involuntary body processes (see **Biofeedback**). Through biofeedback, they learn to raise the skin temperature in their hands. This

Anatomy of the head The bony frame of the head, *left,* is called the skull. Skull bones form a protective case around the brain and serve as a point of attachment for the muscles of the head. These muscles, *right,* play an important role in chewing and swallowing, and they are responsible for facial expressions.



technique can indirectly decrease the blood flow to the scalp, thus diminishing the throbbing of the arteries in the head.

Tension headache is the most widespread kind of headache. It is related to increased tightening of the muscles in the head. When a person is tense or tired or is under extreme mental or physical strain, these muscles may contract, causing a tension headache. The victim has pain in the head or at the back of the head and neck. Most tension headaches can be eased with pain-relieving drugs or with sedatives. Biofeedback therapy may also be helpful.

Headdress. See **Hairdressing; Hat; Indian, American.**

Headhunter is a person who cuts off the head of a dead enemy to keep as a trophy. Headhunting was usually a part of intertribal warfare. The heads were often used in rituals. Headhunters performed ceremonies after a hunt to prevent revenge by the spirits of the dead.

There is evidence that Neanderthal people, a prehistoric group, removed heads for ritual purposes. Headhunting was practised in many parts of the world, particularly in Malaysia, Melanesia, and South America. In South America, the Jívaro Indians of Ecuador removed the skull and used hot sand to shrink the skin of the head to a small size. The avenging soul of the dead person was then believed to be safely trapped inside.

Headphones are a device used for listening in private to various types of equipment that reproduce sound. Such equipment includes compact disc players, record players, radios, tape recorders, and telephones. High-fidelity headphones provide one headphone for each ear. These headphones can reproduce stereophonic sound (see **High-fidelity system** [Headphones]). Headphones are either *circumaural* (almost airtight) or *supra-aural* (relatively loose-fitting). Headphones are sometimes called earphones. One kind of earphone looks like a button and fits in the ear.

All headphones receive electric signals from some type of sound-reproduction equipment and convert the signals into sound. Thus, headphones serve as miniature speakers (see **Speaker**). Various kinds of headphones work by means of different mechanisms. But nearly all such mechanisms function in much the same way as those in high-fidelity headphones.

Headphones are devices used for listening in private to tape recorders and other electronic equipment that reproduces sound. Headphones are widely used in broadcasting, *above.*

Most high-fidelity headphones have three main parts: (1) a coil of wire called a *voice coil,* (2) a cone-shaped piece of paper or plastic called a *diaphragm,* and (3) a permanent magnet. The voice coil is attached to the diaphragm. The permanent magnet is near the voice coil. When electric waves pass through the voice coil, they produce varying magnetic forces in the coil. These forces drive the coil alternately toward and away from the permanent magnet. The coil moves back and forth so rapidly that it vibrates. The vibrations of the coil create vibrations in the diaphragm. The diaphragm's vibrations, in turn, produce vibrations in the air, which the ear hears as sound.

The inventor Alexander Graham Bell made the first earphone in 1876. It formed part of the first telephone.

See also **Telephone** (The receiver; illustration).

Healey, Denis (1917-), was deputy leader of Britain's Labour Party from 1980 to 1983. He had previously served in Labour governments as defence secretary from 1964 to 1970, and chancellor of the exchequer from 1974 to 1979. Denis Healey was born in Whitby, North Yorkshire, and educated at Bradford Grammar School and Balliol College, Oxford. From 1946 to 1952, he was secretary of the Labour Party's international department. Healey became MP for Leeds, South-East, in 1952. He received a life peerage in 1992.

Health is a state of physical, mental, and social well-being. It involves more than just the absence of disease. A truly healthy person not only feels good physically but also has a realistic outlook on life and gets along well with other people. Good health enables people to enjoy life and have the opportunity to achieve the goals they have set for themselves.

To achieve and maintain good health, people must have basic knowledge about the human body and how it functions. Only then can they determine what will or what will not help or damage their health. Therefore, learning about health should be a part of every person's education. Current knowledge about health, together with good living habits, can help almost everyone maintain good health and improve the quality of life.

Society as a whole benefits from people's good health just as individuals do. For that reason, many government and voluntary agencies strive to preserve and improve the health of all people. The World Health Organization (WHO), an agency of the United Nations, works to promote better health throughout the world.

Elements of physical health

All parts of the body must work together properly to maintain physical health. A person who is in good physical condition has the strength and energy to enjoy an active life and withstand the stresses of daily life. Proper nutrition, exercise, rest and sleep, cleanliness, and medical and dental care are all essential to healthy living.

Nutrition. A balanced diet provides all the food substances needed by the body for healthy growth and development. Nutritionists use the term *nutrients* for these substances and classify them into five main groups: (1) carbohydrates, (2) fats, (3) proteins, (4) vitamins, and (5) minerals. Water is also essential for life, but it is often considered separately from nutrients.

A balanced diet consists of a wide variety of foods. Fruit and vegetables provide important vitamins and

Jogging is a good way to get the vigorous exercise necessary for physical fitness. Such exercise strengthens muscles and improves the function of the circulatory and respiratory systems.

minerals. Meat, poultry, fish, eggs, dairy products, and nuts are rich sources of protein. Bread, cereals, and potatoes furnish carbohydrates in addition to vitamins and minerals.

Good nutrition also includes eating the proper amount of food each day. Overeating can lead to *obesity* (fatness). Excess weight puts extra strain on the heart and increases a person's chances of getting such diseases as diabetes and heart disease. Many people try to lose weight quickly and easily by following one of the many widely advertised fad diets. But these diets can be dangerous, especially if used over a long period of time. The safest way to lose weight is to consult a doctor and follow the reducing programme he or she prescribes. Most programmes combine moderate daily exercise with a balanced diet that contains a limited number of calories.

Exercise helps keep the body healthy and fit. Vigorous exercise strengthens muscles and improves the function of the circulatory and respiratory systems. Physical fitness benefits both physical and mental health. It enables the body to withstand stresses that otherwise could cause physical and emotional problems.

To achieve fitness, a person should start an exercise programme slowly and build it up gradually to a level that maintains a healthy heart and strong muscles. Daily exercise provides the greatest benefits, and so it is important to choose exercises that can be performed every day. Such popular activities as bicycling, jogging, and swimming, and even taking long, brisk walks, furnish the vigorous exercise necessary for fitness. Participating in golf, tennis, or some other sport only once or twice a week cannot develop and maintain fitness.

Rest and sleep help overcome fatigue and restore energy to the body. Everyone needs rest and sleep, but the amount required differs for each individual. Most adults sleep from 7 to $8\frac{1}{2}$ hours a night, though some need less sleep and others need more. Young children may need more sleep at night plus a daytime nap.

Nearly everyone has trouble falling asleep occasionally. However, frequent *insomnia* (inability to sleep naturally) can indicate various physical or emotional disorders. Therefore, it is best to consult a doctor about any persistent sleep problem. Some people take sleeping pills to counteract insomnia, but such drugs should not be used without a doctor's prescription.

Rest and relaxation are as important as sleep. After strenuous work or exercise, a person may need a period of total rest. At other times, only relaxation or a change of pace is necessary. Any activity that differs from the normal routine of work or study can be relaxing. Pleasurable and relaxing activities help the body shed tension and remain robust. If rest and relaxation do not relieve fatigue and tension, the individual may have a physical or emotional problem.

Cleanliness controls the growth of bacteria and other germs that can cause disease. A daily bath or shower keeps the body free from dirt and odour. In addition, it helps prevent skin infections that may develop if bacteria grow and multiply on the skin. The hair should also be washed regularly.

Daily dental care is another important part of personal cleanliness. Brushing the teeth properly and using dental floss keep the teeth clean and help prevent decay and gum disease.

Medical and dental care. Regular checkups by a doctor and dentist play an important role in safeguarding health. Doctors recommend that people have medical care at the first sign of any illness. Early care can result in quicker cure. Treating oneself for more than a day or two is unwise unless the condition improves steadily.

Prevention of disease is an important part of medical care. Parents should make sure that their children receive immunization against diphtheria, German measles, measles, mumps, polio, tetanus, and whooping cough. See **Immunization.**

Elements of mental health

Physical health and mental health are closely connected. Mental health plays an important role in both the way people behave and the way they feel. Emotionally healthy individuals accept themselves as they are—with all their weaknesses as well as their strengths. They remain in contact with reality, and they are able to deal with stress and frustration. They also act independently of outside influences and show genuine concern for other people.

Emotional development. Experiences during childhood strongly influence a person's mental health throughout life. An infant is completely helpless at birth and must depend on its parents for all its needs. Children remain dependent for many years, but they slowly mature and learn to do things for themselves. They make many mistakes during this long period of growth and maturation. Children thus develop the knowledge necessary to deal with difficult situations in life. This knowledge helps them maintain good mental health.

Emotional development does not end when a person reaches adulthood. Similarly, an individual's mental health continues to change from time to time. These changes result from daily circumstances that cause either pleasure or pain for the person.

Occupational health hazards threaten the health of many workers. This worker is wearing safety glasses and a respirator to protect his eyes and lungs from harmful substances.

Handling stress is essential for avoiding both mental and physical illness. Feelings of stress are the body's response to any threatening or unfamiliar situation. Most severe stress results from such serious events as bereavement, a divorce, or loss of a job. However, stress can occur even in pleasant situations, such as watching a football game. If not handled properly, stress can lead to physical or emotional illness. It may produce only mild symptoms, such as a cough, a headache, or a rash. But severe and prolonged stress can contribute to serious health problems, including high blood pressure and stomach ulcers.

No one can avoid stress, but a person can lessen the danger of becoming ill from it. Regular exercise and sufficient sleep strengthen the body's resistance to stress. Everyone should learn to relax by resting, taking a walk, meditating, pursuing a hobby, or by any other method that he or she finds successful.

Social relationships have an important influence on mental health. Close personal relationships with friends and relatives provide opportunities for communication, sharing, and emotional growth. Such relationships also can provide strength and support for dealing with challenging situations or personal problems.

Health hazards

The nature of health problems in the industrialized nations has changed dramatically during the 1900's. Until then, most people died from infectious diseases, such as diphtheria or pneumonia. Today, however, infectious diseases are no longer the main killers. Improved sanitation, immunization programmes, and the development of antibiotic drugs have brought these diseases under control. Today, health specialists are concerned chiefly with diseases related to the aging process, unhealthy lifestyles, and environmental hazards.

Tobacco, alcohol, and drug abuse. Cigarette smoking is a principal cause of unnecessary and preventable illness and early death. Heart disease and lung cancer and other lung diseases occur at a much higher rate among smokers than among nonsmokers.

Many individuals use various drugs in an effort to solve their problems or to improve their alertness, mood, or self-confidence. However, the regular use of alcohol, narcotics, or sedatives can lead to addiction and also serious damage to the body. People may become psychologically dependent on a wide variety of other drugs, including amphetamines, cocaine, LSD, marijuana, and tranquillizers. These individuals may harm themselves further by neglecting their health and nutrition. In addition, drugs can distort a person's judgment and so increase the risk of accidents.

Alcohol is the most widely abused drug in the western world. About a tenth of all drinkers become alcoholics. There is no cure for alcoholism, but the condition can be treated. An alcoholic who gives up drinking can return to a healthy, productive life.

Environmental health hazards caused by modern technology can produce serious problems. Air pollution can worsen the condition of people who suffer such respiratory diseases as asthma and bronchitis. It may even help cause some diseases, including cancer and emphysema. In some areas, insecticides and industrial wastes contaminate food and water supplies. Excessive noise can also threaten people's health. Noise coming from aeroplanes, construction projects, and industrial plants can cause hearing loss as well as emotional damage.

Occupational health hazards threaten the health of many workers. In some cases, substances involved in a person's job may cause long-term damage that appears only after many years. For example, many coal miners develop a lung disease called *pneumoconiosis* from inhaling coal dust. Dust also causes lung diseases among workers in the asbestos and cotton industries. Some industrial chemicals, including arsenic and vinyl chloride, cause cancer. People who work with X rays and other forms of radiation also face a health hazard unless proper precautions are taken.

Public health

Public health includes all actions taken to maintain and improve the general health of a community. Government health programmes provide most public health services. In addition, many voluntary health agencies receive contributions to combat specific diseases, such as cancer and lung disease. These agencies provide medical services, campaign for health legislation, and make important contributions to health education.

In many countries, health departments provide a wide range of services in most communities. For example, they work to prevent and control disease by providing proper sanitation, conducting immunization programmes, and enforcing quarantine regulations. Another important function of public health agencies is to provide health education for individuals, groups, and organizations.

Related articles in *World Book.* See **Public health** and its list of *Related articles.* See also the following articles:

Biographies

Barton, Clara
Curie, Marie Sklodowska
Fleming, Sir Alexander
Galen
Hippocrates
Jenner, Edward
Koch, Robert
Lister, Sir Joseph
Metchnikoff, Élie
Nightingale, Florence
Pasteur, Louis
Reed, Walter
Sabin, Albert B.
Salk, Jonas E.
Servetus, Michael
Trudeau, Edward L.

Personal health

Alcoholism
Baby
Bath
Child
Cigarette
Circumcision
Diet
Disease
Drug abuse
Fat (Fats and disease)
Fatigue
Food
Growth
Human body
Immunity
Immunization
Nutrition
Physical fitness
Posture
Sauna
Sleep
Smoking
Stress
Teeth (Care of the teeth and gums)
Weight control

Other related articles

Environmental pollution
Holistic medicine
Medicine
Physical education
Recreation
Safety
UNICEF
World Health Organization

Health insurance. See **Insurance** (Private health insurance); **Health care plans; Health insurance, National; Medicine** (Financing medical care; Financial problems).

Health insurance, National, is a government programme that finances extensive health services for the majority of the people in a country. This type of programme is sometimes called *socialized medicine.* Every industrial nation except the United States has some form of national health insurance, also called *NHI.* In the United States, a private health insurance system is operated. The first NHI plan was established in Germany in 1883.

The British *National Health Service* is a system of state-funded medical care that covers virtually all the people of Britain. It also covers overseas visitors who become ill while in Britain. Employed people in Britain pay weekly health insurance contributions to help finance the service. But most of the funds for the service come from taxes.

The idea of a national health service arose from anxiety about the unhealthy living conditions that resulted from the rapid industrialization in the 1800's. In 1848, the General Board of Health was created. In 1872, a Public Health Act made it compulsory for each area of the country to have a medical officer of health, who was responsible for all the medical facilities provided in his or her area.

In 1911, a health insurance scheme was started, but it covered only a third of the population. The Beveridge Report in 1942 recommended the setting up of a full-scale scheme. The National Health Service eventually came into being on July 5, 1948.

Australia's national health scheme, known as *Medicare,* was introduced by the Labor government in 1984. Under Medicare, all Australians are covered for the costs of basic health and hospital care. Medicare is financed by a tax levied on all incomes. About 65 private health insurance funds offer insurance for services and items not covered by Medicare. Such services and items include private hospital treatment, dental work, and spectacles. Medibank Private, a government organization, competes with the private health funds by offering insurance coverage for items not covered by Medicare.

Under the Pharmaceutical Benefits Scheme, the federal government provides a wide range of medicine free to pensioners and, at a subsidized rate, to the general public. Unemployed people and low-income earners receive medicines at a greater level of subsidy.

Health resort. See **Bath** (Medical bathing).

Heard Island is an Australian territory in the far southern Indian Ocean. It lies about 4,000 kilometres southwest of Fremantle. Heard Island is about 43 kilometres long and 21 kilometres wide. Britain transferred the island to Australia in 1947. An Australian weather station operated there from 1947 to 1955.

Hearing. See **Ear** (The sense of hearing).

Hearing aid is a device that improves hearing. Many hearing-impaired persons depend on this device. It enables them to use the telephone, enjoy music, and more easily understand conversation.

Types of hearing aids. There are two types of hearing aids. The *air-conduction aid* amplifies sound and brings it directly to the ear. Not all people can use this type, because they cannot transmit sounds through their inner and outer ear. These people use *bone-conduction aids* that bring sound waves to the bony part of the head, usually directly behind the ear. The bone transmits the vibrations to the auditory nerves of the cochlea. Hearing is possible when the auditory nerves are stimulated.

Electronic hearing aids are essentially small telephones. They consist of a microphone, an amplifier, and a receiver. The receiver fits in the ear. In the case of bone conduction, it fits behind the ear. The first electronic hearing aid was developed about 1900. It was bulky and inconvenient to use.

People made only limited use of hearing aids until the development of the *valve aid.* These used a crystal microphone, a valve amplifier, and two batteries. They were much more compact, and easier to carry and conceal. These factors helped many people overcome their reluctance to wear hearing aids.

Another important advance in hearing aids took place in 1953 with the introduction of an electronic *transistor hearing aid.* This device has completely replaced the valve hearing aid, because it is much smaller and less expensive to operate.

Modern hearing aids may be adjusted to a wide range of frequencies and intensities. They can also be easily concealed because of their compactness. They are made in a wide range of styles and designs, so that they also serve an ornamental purpose. Many such hearing aids are worn in women's hair or are built into the frames of spectacles.

History. Air-conduction aids and bone-conduction aids have been used for hundreds of years. The principle of bone conduction was known in the early 1600's. The ear trumpet was used even earlier. In the late 1700's, the *audiphone,* or *dentiphone,* was invented. It was a cardboard or celluloid device shaped like a fan. Users held the edge between their teeth and bent the fan toward the sound. The sound vibrations travelled from the teeth to the jawbone, the skull, and to the auditory nerves.

In 1872, Alexander Graham Bell began to experiment on an electrical mechanism that would help deaf children to hear. His experiments led directly to the development of the telephone. Bell himself never invented a hearing aid. But his influence increased as a result of his invention, and he did much to call attention to the problems of the hard of hearing.

Hearing dog. See Dog, Guide.

Hearing loss. See Deafness.

Hearn, Lafcadio (1850-1904), was an American author. His best-known works display a weird imagination and a polished style. Hearn said, "I have pledged myself to the worship of the Odd, the Queer, the Strange, the Exotic, and the Monstrous."

Hearn was born in the Ionian Islands off the west coast of Greece. He moved to the United States at the age of 19 and eventually settled in New Orleans. There he wrote a series of eerie newspaper sketches called "Fantastics." After living for a time in the West Indies and New York City, he moved to Japan in 1890. Hearn became a Japanese citizen and a professor of English literature at the Imperial University of Tokyo.

Hearn wrote many fantastic and supernatural tales. They were collected in such works as *Some Chinese Ghosts* (1887) and *Kwaidan* (1904). His first and best-known novel is *Chita* (1889). Hearn also wrote several books about Japan.

Hearne, Samuel (1745-1792), was an English explorer and fur trader. He was the first white person to journey overland from Hudson Bay to the Arctic Ocean. He reached the Arctic Ocean in July 1771, while exploring for the Hudson's Bay Company. He arrived at Great Slave Lake in northern Canada later that year. Hearne set up the first Hudson's Bay Company inland post in Saskatchewan in 1774. He commanded Fort Prince of Wales in Manitoba from 1775 until the French seized it in 1782. In 1783, he set up a post at Churchill, Manitoba. He returned to England in 1787. Hearne was born in London. He joined the Hudson's Bay Company about 1765.

Hearst, William Randolph (1863-1951), was an American publisher of newspapers and magazines. He developed a sensational journalistic style which critics described as *yellow journalism.*

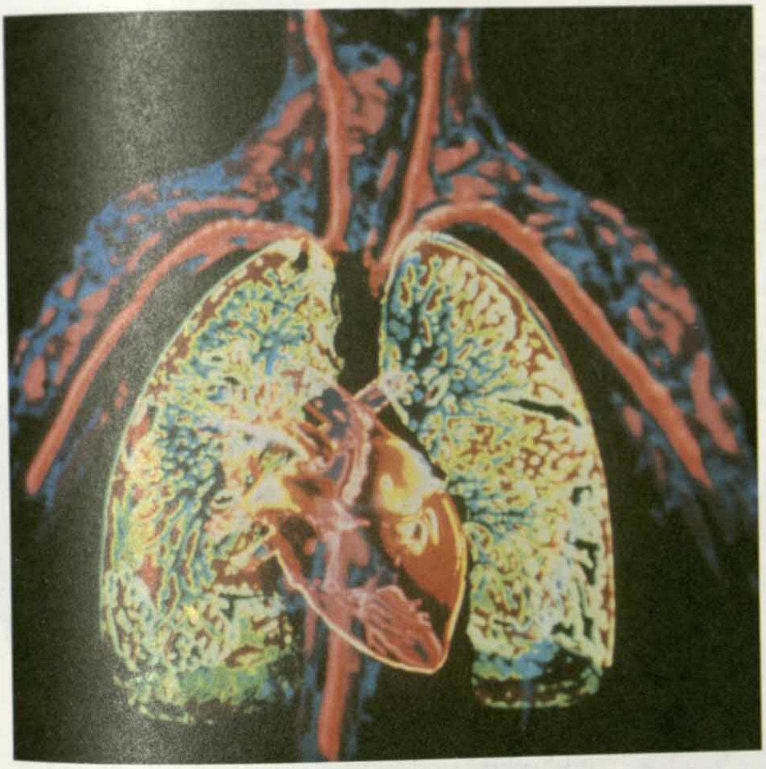
Hearst was born in San Francisco and attended Harvard University. In 1885, he was expelled from college because of a practical joke he played on his professors. His father then gave him the *San Francisco Examiner.* Hearst made this newspaper a financial success. In 1895, he bought the *New York Journal.* He matched the *Journal* against Joseph Pulitzer's *The* (New York) *World* in a circulation battle, which reached its height in 1898 during the Spanish-American War.

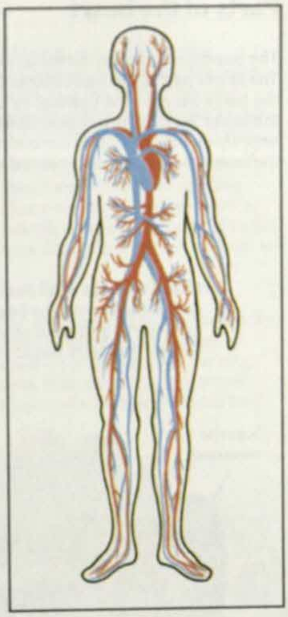
Hearst pioneered in colour comics, Sunday supplements, banner headlines, and editorial crusading. He represented New York in the U.S. House of Representatives from 1903 to 1907. In 1904, he sought the Democratic nomination for President.

Modern hearing aids serve the wearer's individual needs. An all-in-the-ear hearing aid, *left,* corrects moderate hearing loss. A behind-the-ear model, *right,* is for more serious hearing loss.

The ear trumpet, one of the earliest hearing aids used, gathered in sound from a large area and funnelled it into the ear.

A tactile aid can help people with severe hearing loss. The unit translates sounds into vibrations that the wearer can feel.





The heart is a hollow muscular organ that pumps blood throughout the body. The heart lies in the centre of the chest, between the lungs, *above.* As it rhythmically beats, the heart sends blood coursing through the arteries and veins of the circulatory system, *right.*

Heart

Heart is the wondrous pump that powers the human body. With each heartbeat, it sends life-giving blood throughout the body. Blood carries oxygen and food to all the body cells. The rhythmic beating of the heart begins about seven months before we are born. When the heart stops beating, we die unless a special device circulates and oxygenates our blood.

The heart is a large, hollow, muscular organ divided into two pumps that lie side by side. Veins transport blood from throughout the body to the right-sided pump. That pump sends the blood to the lungs, where it picks up oxygen. The oxygenated blood then flows to the left side of the heart, which pumps it through arteries to the rest of the body. Valves control the flow of blood through the heart. The left-sided pump, which delivers blood throughout the body, is larger and stronger than the right pump. The heart, together with the tubelike structures that transport the blood through the body—the arteries, veins, and capillaries—are called the *circulatory system* or *cardiovascular system.*

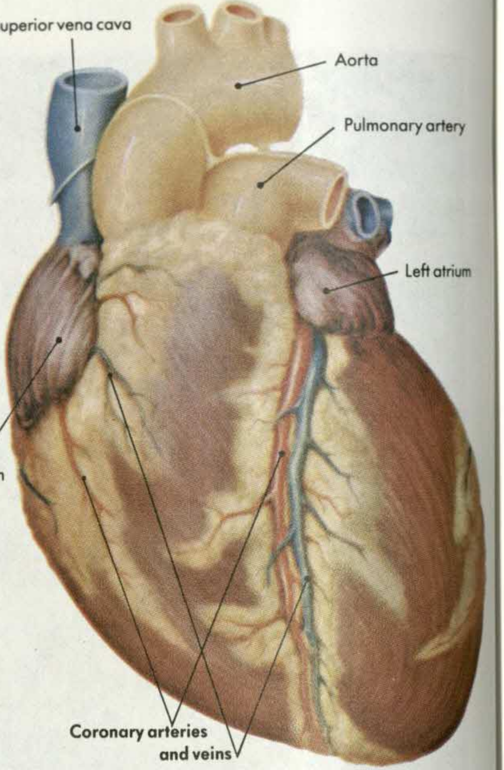
The nervous system regulates the heart and other parts of the circulatory system. A division of the nervous system, the *autonomic nervous system,* automatically controls the heart rate, increasing or decreasing it, depending on the body's needs. For example, the heart pumps slowly while a person sleeps, providing relatively small amounts of oxygen to the body. But the heart rate can be quickly speeded up again and so increase the oxygen output enormously. This will happen when a person exercises, becomes frightened, or needs to fight or run.

Disease can strike any part of the heart. Disorders of the heart and blood vessels are the leading cause of death in the industrialized world. The most common heart disease affects the arteries that supply the heart muscle itself with blood. Disorders of these arteries usually develop over a person's lifetime. Deposits of fatty material block the arteries and so reduce the blood supply to the heart. If the heart muscle receives too little blood, it may work poorly or even die. Damage to the heart muscle resulting from a shortage of blood is called a heart attack. A mild heart attack may force a person to lead a less active life. A severe attack may make the heart unable to supply the body with enough blood even at rest and so cause a person's death. Disease may also strike other parts of the heart with equally destructive effects.

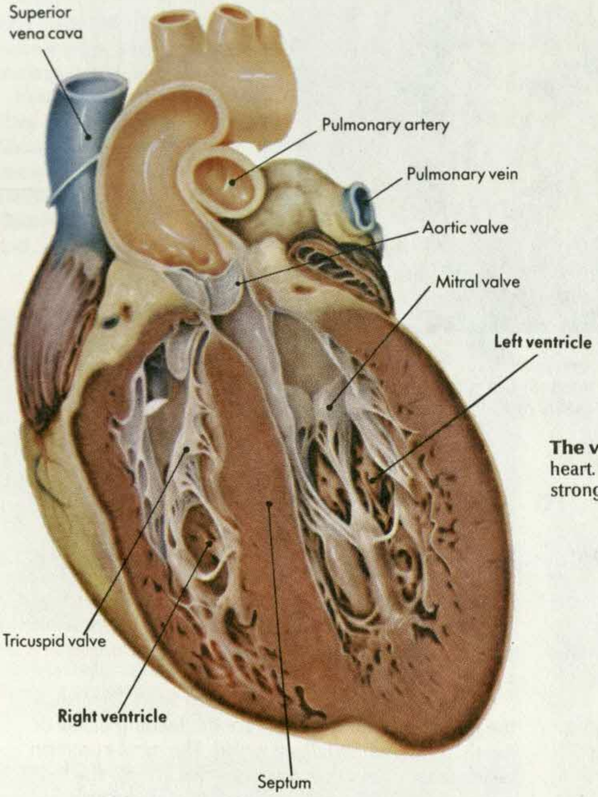
Some of the most exciting advances in medicine have been in *cardiology,* the medical field that deals with diseases of the heart and blood vessels. For thousands

Parts of the heart

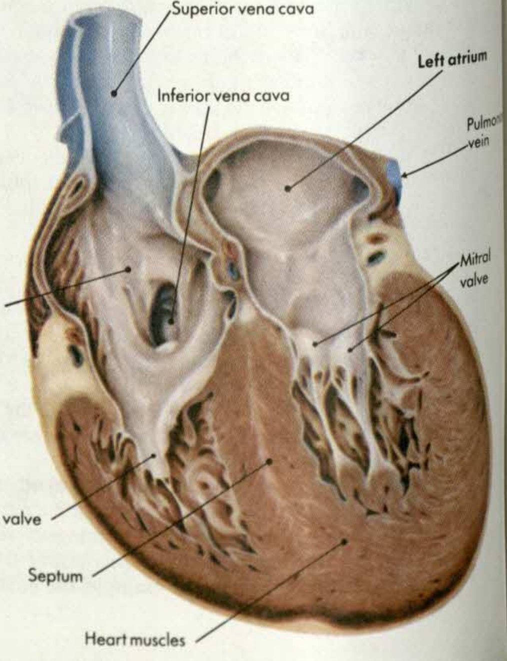
The heart lies between the lungs at the centre of the chest. The lower part of the heart points toward the left side of the body. Because the beating, or pumping, takes place in the lower part, many persons incorrectly think the heart is entirely on the left side of the body. This illustration shows the heart about two-thirds normal size.



Blood vessels of all sizes serve the heart. Coronary arteries and veins nourish the heart muscle itself. The superior vena cava, aorta, and pulmonary artery are among the large blood vessels that carry blood in and out of the heart.



The ventricles, *left,* make up the largest part of the heart. They form the whole lower portion. Their thick, strong muscles pump blood throughout the body.



The atria, *right,* form the upper, smaller part of the heart. They have thin walls and are smaller than the ventricles. Each atrium serves as a collecting station for the blood that flows into the heart.

Interesting facts about the heart

The human heart is fully developed about eight weeks after conception, *right,* when the embryo is only about 2.5 centimetres long. The heart begins to beat even earlier—four weeks after conception, when it is just a simple tube.

Ancient Egyptians believed that the heart was the centre of the emotions and the intellect. An illustration from the ancient Egyptian Book of the Dead shows the god Anubis weighing a dead person's heart against a feather, the symbol of truth.

The body's entire supply of blood, about 4.7 litres, is pumped through the body every minute. In one day, the heart pumps nearly 7,600 litres of blood. In a 70-year lifetime, the heart pumps about 193 million litres of blood and beats $2\frac{1}{2}$ billion times.

Diseases of the heart and blood vessels are the leading cause of death in the industrialized world. More than twice as many people die from cardiovascular diseases as from all forms of cancer. More than half of these deaths are caused by heart attacks.

Heart muscle differs in several ways from other muscles in the body. For instance, heart muscle has certain cells that act as "leaders." These cells contract and relax rhythmically, causing surrounding cells to do the same. Even when the leader cells are removed from the heart, they continue their rhythmic beat.

A tireless, powerful muscle, the heart is able to perform enough work in the period of one hour to lift 1,400 kilograms—roughly the weight of a small car—as much as 30 centimetres off the ground.

of years, people with heart diseases did not even know they had such a problem. In the 1900's, doctors have learned to diagnose and treat certain heart conditions that once meant death. Discoveries of new drugs and the great progress in surgery have added years to the lives of many heart patients. Doctors have transplanted hearts and even developed machines that can temporarily do the work of the heart.

Today, much research in cardiology focuses on learning about the causes of heart disease so that it can be prevented. Other research seeks to reduce death and disability from heart disease through the further development of new medicines and surgical techniques. For patients who have untreatable disorders, research continues into improving heart transplantation and producing an effective artificial heart.

This article chiefly discusses the human heart. The last section describes the hearts of insects, fish, birds, and other animals. For information on what blood does in the body, see the *World Book* articles on **Blood** and **Circulatory system.**

The structure of the heart

Each person's heart is about the same size as that person's fist. A newborn baby's heart weighs only about 20 grams. An adult's heart weighs as much as from 250 to 320 grams. The heart lies near the middle of the chest, between the lungs. The heart is situated closer to the front of the chest than to the back and slightly to the left side.

Muscular walls. The heart consists chiefly of muscle. Heart muscle, also called *myocardium* or *cardiac muscle,* forms the walls of the heart as well as the *septum,* a wall that divides the left and right sides of the heart. All the muscles contract and relax, thereby pushing blood through the heart.

A membrane called the *epicardium* covers the outer surface of the heart. Another membrane, the *pericardium,* surrounds the epicardium. It completely encloses the heart and extends above the blood vessels that emerge from the top of the heart. A slippery fluid between the epicardium and the pericardium enables the heart to contract smoothly.

Heart muscle differs from the other muscles of the body—skeletal and smooth muscles. Skeletal muscles, such as those in the arms and legs, have long fibres with alternate dark and light bands called *striations.* We can consciously control the skeletal muscles. Smooth muscles form the walls of the stomach, intestines, and most other internal organs. The muscles lack striations, and

Heart terms

Angina pectoris, is chest pain that occurs when the heart does not receive enough blood.

Angiography, is a technique used to X ray blood vessels.

Angioplasty, is a technique used to clear arteries that have become blocked with fatty deposits.

Arrhythmia, is an abnormal heart rhythm.

Arteriosclerosis, is the hardening, thickening, and loss of elasticity in artery walls.

Atherosclerosis, is the formation of fat deposits on the inner lining of arteries.

Atrium, is either of the two upper chambers of the heart.

Cardiology, is the branch of medicine that deals with the diagnosis and treatment of disorders of the heart.

Coronary arteries are the vessels that supply oxygen-rich blood to the heart muscle itself.

Coronary artery disease (CAD) is the narrowing of the arteries that supply blood to the heart, reducing the amount of blood the heart muscle receives.

Coronary bypass is a type of surgery used to rechannel blood flow past blocked coronary arteries.

Diastole, is the period of heart activity when the ventricles relax.

Electrocardiograph (ECG) is an instrument used to detect heart damage or diagnose heart disorders.

Heart attack is a sudden and complete blockage of a coronary artery, stopping blood flow to one section of heart muscle.

Heart failure occurs when the heart fails to pump enough blood.

Systole, is the period of heart activity when the ventricles contract.

Ventricle, is either of the two lower chambers of the heart.

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we do not consciously control them. They work automatically. Heart muscle has striations like skeletal muscle. But it contracts and relaxes automatically like smooth muscle. In addition, heart muscle cells act as one cell. When one heart muscle cell contracts or relaxes, the cells around it do the same. For that reason, the heart beats continuously and rhythmically throughout a person's life.

Chambers. The septum divides the heart lengthwise, and valves divide it crosswise. Each side of the heart thus has two chambers, one above the other. A thin membrane called the *endocardium* lines each chamber. The top chambers, called the *right atrium* and *left atrium,* receive and collect blood returning to the heart through the veins. After the *atria* (plural of *atrium*) have filled with blood, they contract and squeeze blood into the lower chambers, called the *right ventricle* and *left ventricle.* After the ventricles have filled, they contract and pump blood out of the heart through the arteries. The ventricles have extremely thick walls. The ventricles, which must squeeze blood from the heart, are much larger and stronger than the atria.

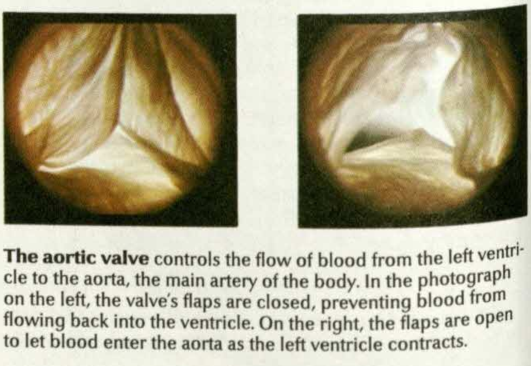
Blood vessels. Blood enters and leaves the heart through several major vessels. Blood from the body flows into the right atrium through the body's two largest veins. The *superior vena cava* brings blood from the head and arms. The *inferior vena cava* carries blood from the trunk and legs. Other blood vessels transport blood between the heart and lungs. *Pulmonary veins* return blood from the lungs to the left atrium. The *pulmonary artery* carries blood from the right ventricle to the lungs. The *aorta* is the largest artery. It receives oxygenated blood from the left ventricle and, through numerous branches, distributes it throughout the body. The pulmonary artery and the aorta are sometimes called the *great vessels.*

The first arteries that branch from the aorta are the two major *coronary arteries.* They bring blood to the heart and so enable it to continue pumping. These two coronary arteries divide into many branches as they cover the heart. Diseases that affect the coronary arteries are among the most serious problems cardiologists treat because the arteries nourish the heart muscle itself.

Valves regulate the flow of blood through the heart. The valves have flaps that open as blood pours from a chamber. When the flaps close, they prevent blood from flowing back into the chamber. Two valves separate the atria and the ventricles. They are called the *atrioventricular valves* or *AV valves.* The AV valve between the right atrium and right ventricle has three flaps and is called the *tricuspid valve.* The AV valve on the left side of the heart has two flaps and is called the *mitral valve.* The heart also has a valve, called a *semilunar valve,* between each ventricle and its great vessel—the pulmonary artery or the aorta. Each semilunar valve has three flaps shaped like half moons. When the right ventricle contracts, it delivers blood to the pulmonary artery. The semilunar valve that controls the blood flow to the pulmonary artery is known as the *pulmonary valve.* The left ventricle squeezes blood into the aorta. The semilunar valve on the left side is called the *aortic valve.*

The work of the heart

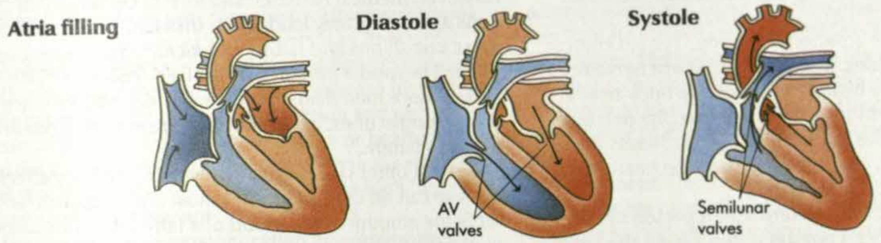
Pumping blood to the lungs. Blood from the body that enters the right side of the heart contains *carbon dioxide,* a gaseous waste the cells produce in creating energy. Blood enters the right atrium through the superior vena cava and inferior vena cava. The atrium fills with

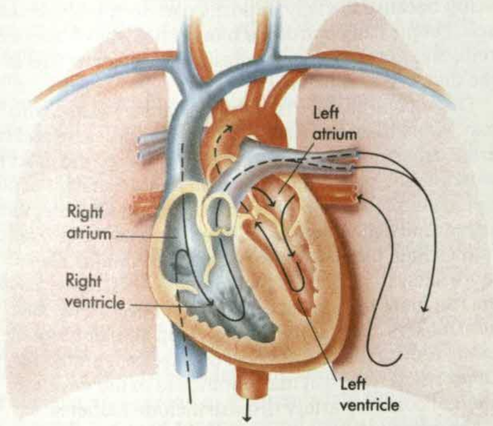


The aortic valve controls the flow of blood from the left ventricle to the aorta, the main artery of the body. In the photograph on the left, the valve's flaps are closed, preventing blood from flowing back into the ventricle. On the right, the flaps are open to let blood enter the aorta as the left ventricle contracts.

How the heart pumps blood

Deoxygenated blood, *shown in blue,* enters the right side of the heart. Oxygenated blood, *shown in red,* enters the left side. The two sides of the heart pump in unison. The right and left atria contract at the same time, as do the right and left ventricles.





Blood goes from the right side of the heart to the lungs. It returns to the left side, from where it is pumped out to the body.

Atria filling. The heart beat is a continuous action. The atria fill with blood at the same time as the ventricles squeeze blood out to the lungs and the body. The atria collect blood and pump it to the ventricles.

Diastole. The atrioventricular (AV) valves open and the atria contract slightly, causing blood to flow from the atria into the ventricles. This stage, during which the ventricles are relaxed and passively receive blood, is called *diastole.* The AV valves close when the ventricles are filled.

Systole. When the AV valves close, the semilunar valves open. The ventricles contract strongly, squeezing blood out of the heart through the semilunar valves. This stage, when the ventricles contract, is called *systole.* While the ventricles are still contracting, the atria begin to fill with blood again.

blood and then contracts, squeezing the blood through the tricuspid valve into the right ventricle. After the ventricle is filled, pressure forces the tricuspid valve to close and the pulmonary valve, leading to the pulmonary artery, to open. The ventricle contracts, and the blood gushes through the pulmonary artery and into the lungs. In the lungs, carbon dioxide is removed from the blood and oxygen is added. The oxygenated blood then flows through the pulmonary veins to the left side of the heart. See **Lung.**

Pumping blood throughout the body. Oxygenated blood from the lungs enters and fills the left atrium. The atrium then contracts, which squeezes the blood through the mitral valve into the left ventricle. After blood fills the ventricle, the mitral valve closes and the aortic valve opens. Blood pours into the aorta and flows through arteries to the body tissues.

Regulating the heart rate. Both sides of the heart pump blood at the same time. As the right ventricle contracts and sends blood to the lungs, the left ventricle contracts and squeezes blood out to the body. The heart's cycle of activity has two periods, *systole* and *diastole.* Systole occurs when the ventricles contract, and diastole when they relax. One complete contraction and relaxation of the heart muscle makes up one heartbeat.

The contraction and relaxation of the ventricles also open and close the heart valves. Closing of the valves produces the "lub-dup" sound of the heartbeat, which doctors can hear with an instrument called a *stethoscope.* As the ventricles contract, the mitral and tricuspid valves close, causing the first sound of a heartbeat. Immediately after the valves close, pressure in the ventricles forces the aortic and pulmonary valves to open. After the contraction ends, pressure in the ventricle drops. The aortic and pulmonary valves then close, causing the second heart sound. The pressure in the atria is then greater than in the ventricles, and so the tricuspid and mitral valves open and blood begins to fill the ventricles again.

The autonomic nervous system controls the heart rate. Special cells send electrical *impulses* (nerve signals) through the heart, causing it to contract and relax rhythmically. The impulse begins in a small bundle of muscle fibres called the *sinoatrial node,* or *S-A node.* The S-A node is often called the *pacemaker* of the heart because it sets the pace of the heartbeat as it sends out rhythmic signals. The S-A node lies in the right atrium near where the superior vena cava enters the heart. The S-A node sends impulses along certain pathways, causing the atria to contract when the electrical signal reaches them. The impulse then arrives at another node, called the *atrioventricular node,* or *A-V node.* The A-V node lies between the atria and ventricles. It delays the nerve signal briefly, allowing the ventricles enough time to fill with blood. As the impulse continues, the ventricles contract.

The nerves of the autonomic nervous system control the S-A and A-V nodes. Stimulation of those nerves can quicken or slow the heartbeat. When the body needs more blood, as during vigorous exercise, the nervous system stimulates the S-A node, which increases the rate of its impulses. The impulses keep the heart chambers contracting at a faster speed.

A person's size largely determines a person's resting heart rate. The bigger a person is, the slower the heart rate. A newborn baby's heart beats about 120 times per minute. The typical rate for adults is 72 beats per minute. But doctors consider resting rates from 60 to 100 beats per minute within the normal range. Athletic training enlarges the heart and slows the heartbeat. Many well-trained athletes have resting rates from 40 to 60 beats per minute.

Regulating blood pressure. Blood in the circulatory system, like water in the pipes of a water system, is always under pressure. Blood pressure refers to the force with which the blood pushes against the walls of the arteries. That force drives blood from the heart to all parts of the body. Each person's blood pressure reflects the amount of blood in the body, the strength and rate of the heart's contractions, and the elasticity of the arteries. Because the heart pumps in cycles, pressure in the arteries rises and falls during systole and diastole. Contraction of the heart produces *systolic blood pressure,* and relaxation produces *diastolic blood pressure.* To learn how blood pressure is measured, see **Blood pressure**.

The heart helps regulate blood pressure by producing a hormone that aids the kidneys in eliminating salt from the body. Excess salt may contribute to high blood pressure, a condition doctors call *hypertension.* Hypertension can injure the heart, brain, and kidneys. Over many years, it can damage arteries and lead to heart disease. See **Hypertension.**

Coronary artery disease

Disease can strike any part of the heart. However, the term *heart disease* usually means *coronary artery disease* (CAD), sometimes called *ischaemic heart disease* (IHD). It is the most common form of heart disease. The condition affects the blood vessels that nourish the heart itself. CAD narrows the coronary arteries and so reduces the blood supply to the heart.

About 5 per cent of the blood pumped from the heart goes directly to the coronary arteries. The blood carries the oxygen and dissolved *nutrients* (foods) the heart needs to do its work. The heart can store most nutrients. But it cannot store oxygen and needs a constant supply. Coronary artery disease may affect the heart's ability to pump by reducing or stopping the oxygen supply.

Some people with CAD suffer severe pain. Others feel no pain and do not even know they have a heart problem. If the disease worsens, a heart attack may result. A heart attack damages the heart muscle or may even cause sudden death. Most cases of CAD can be treated, but the disease should be *diagnosed* (identified) as soon as possible.

Risk factors. Cardiologists cannot say for certain who will be liable to develop coronary artery disease. However, medical research shows that certain conditions and habits may lead to the disease. Doctors call those conditions and habits *risk factors.* Some risk factors fall beyond a person's control. For example, CAD strikes more men than women and older people more than younger ones. In addition, the disease may run in a person's family.

Several other risk factors involved in coronary artery disease can be controlled. The most important risk factor is the amount in the blood of a fatty substance called *cholesterol.* The higher a person's cholesterol level is, the more likely it is that coronary artery disease will develop because the fatty deposits narrow the blood vessels. People can control the blood cholesterol level by reducing the amount of cholesterol and animal fats in the diet. See **Cholesterol.**

Other controllable risk factors that may cause coronary artery disease include high blood pressure and cigarette smoking. High blood pressure forces the heart to work harder, which may bring on a heart attack. People can lower their blood pressure by losing weight, exercising, and eating less salt. Certain medicines also help reduce high blood pressure. Cigarette smokers are more likely to have CAD than nonsmokers. Heavy smokers run more than twice the risk of a heart attack than nonsmokers. But people who give up smoking significantly reduce the risk of heart disease (see **Smoking**). Other risk factors that may contribute to the development of coronary artery disease include diabetes, extreme *obesity* (fatness), and stress.

Regular medical examinations often reveal the development of controllable risk factors. Doctors may then advise patients to stop smoking or to follow a specific diet to control high blood pressure, the cholesterol level, or weight.

Causes. Nearly all coronary artery disease results from *arteriosclerosis*—a hardening, thickening, and loss of elasticity of the artery walls. In most cases, the inner layer of the artery wall becomes damaged, causing a form of arteriosclerosis called *atherosclerosis.* The inner walls of healthy arteries are smooth, and so blood flows easily. But in atherosclerosis, deposits of fats and calcium build up on the inner walls, hampering the blood flow through the artery. The fat and calcium deposits are called *plaques.*

Plaques can completely block an artery and stop the blood flow. In addition, they can narrow an artery and so reduce blood flow enough to form a *thrombus* (blood clot). Plaques often crack, releasing substances that also can lead to blood clots. If a blood clot blocks a coronary artery, it causes a heart attack. A blood clot that occurs in an artery in the brain causes a stroke. See **Stroke.**

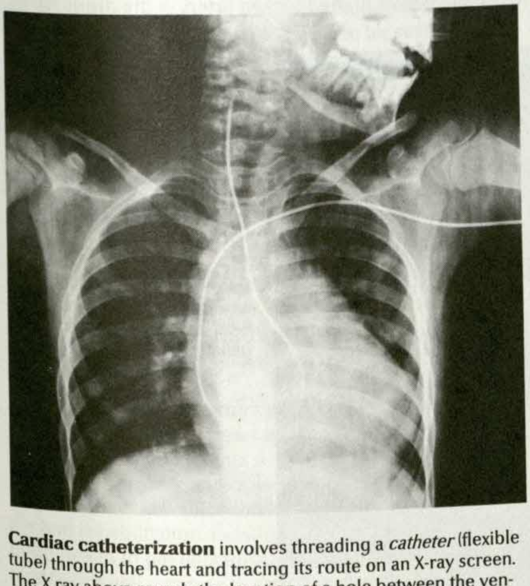
Symptoms and diagnosis. Coronary atherosclerosis usually takes many years to develop. Doctors have found coronary artery plaques in young soldiers killed in battle. But symptoms seldom occur until age 50 or later. In some cases, the first symptom is a heart attack or sudden death. However, a typical early symptom may be pain in the chest from exercising or some other activity that makes the heart work harder than usual. Doctors call such pain *angina pectoris,* or simply *angina.* The narrowed coronary arteries supply the heart with less oxygen, which may cause pain when the heart must work harder. After the exercising or other activity is stopped, the pain usually disappears. However, angina may worsen if left untreated. Patients may then suffer from frequent attacks, even when resting.

Doctors diagnose coronary artery disease by studying their patients general physical condition and past illnesses. They note any history of angina or heart attack and the presence of any risk factors. Physical examination may reveal other risk factors, such as high blood pressure or heart damage.

Doctors use an instrument called an *electrocardiograph* to detect heart damage or disturbances of the heart rhythm. The instrument produces a record called an *electrocardiogram* (ECG), which displays the electrical activity of the heart muscle. The impulses are printed on moving paper that shows the heart's electrical activity as a series of wavy lines. Major waves represent contraction of the ventricles. Minor waves represent relaxation of the ventricles and contraction and relaxation of the atria. Most ECG's are taken with the patient lying down. But many doctors take a patient's ECG during exercise. Such a *stress ECG* shows whether a patient's heart—even if the patient has no chest pain—receives enough oxygen during vigorous exercise. See **Electrocardiograph**.

Doctors also use a method called *radionuclide imaging* to detect CAD. A doctor injects a radioactive element into a patient's bloodstream. The doctor can view the element on a screen as it spreads into the heart muscle. Areas that do not receive blood appear blank on the image. Doctors generally use radionuclide imaging with a stress ECG.

If the usual diagnostic techniques leave doubt, doctors may perform *cardiac catheterization* followed by *coronary angiography.* They insert a long, flexible tube called a *catheter* through a large blood vessel, usually an artery in the area where the thigh and abdomen meet. They push the catheter up to where the coronary arteries begin and inject dye. The inside of the arteries can then be viewed and recorded on X-ray film called an *angiogram.* The test clearly shows the condition of the coronary arteries. Coronary angiography presents a small risk of injury or even death. Doctors therefore perform it only in difficult diagnostic cases. See **Angiography**.



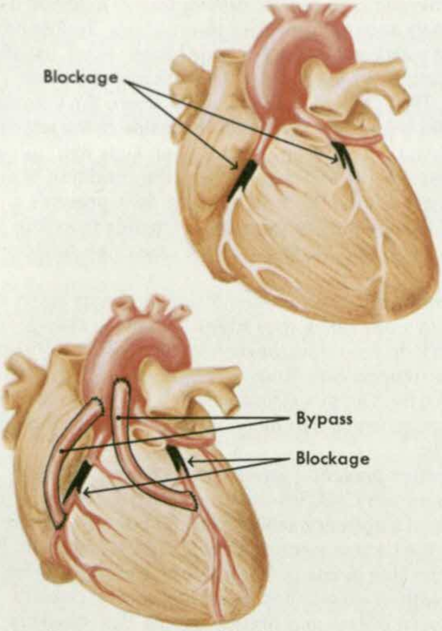
Cardiac catheterization involves threading a *catheter* (flexible tube) through the heart and tracing its route on an X-ray screen. The X ray above reveals the location of a hole between the ventricles. The tube was inserted into a vein in the arm and guided into the heart, through the hole, and up the carotid artery.

Treatment. Doctors cannot cure coronary artery disease. In some cases, they advise patients to change their life style to help slow the development of CAD. Victims can be treated with drugs or surgery to help them live a normal life. Doctors evaluate each patient with CAD to determine which treatment would provide the greatest benefit.

Doctors prescribe various drugs to treat different symptoms of CAD. Several drugs relieve angina. For example, *nitroglycerin* tablets placed under the tongue enlarge the coronary arteries, enabling more blood to flow past the fatty deposits. Nitroglycerin can stop angina pain within two minutes. *Beta-blockers* and *calcium channel blockers* may prevent angina. Beta-blockers slow the action of the heart and reduce its contracting force. The heart's demand for oxygen then decreases, making it easier for the heart to pump. Calcium channel blockers work like beta-blockers on the heart and also relax the coronary arteries. The two drugs also relieve high blood pressure. The drug *digitalis* strengthens the action of weak hearts. Many doctors advise coronary artery disease patients to take one aspirin tablet a day. Aspirin thins the blood and can help prevent blood clots in the coronary arteries.

If drugs fail to control coronary artery disease, doctors consider other techniques to correct the problem. In the easiest technique, *coronary angioplasty* or simply *angioplasty,* doctors insert a catheter with a deflated balloon attached into the narrowed area of the coronary artery. They then inflate the balloon, which pushes the blockage aside and enlarges the artery. Angioplasty works in about 85 per cent of patients at first. But in about a third of those patients, blockage returns within three months. For some patients, various methods may prolong the benefits of angioplasty. For example, intense beams of light from devices called *lasers* burn away new plaque deposits. Or the placement of tiny metal props in the artery may keep it open. See **Angioplasty**.

Should catheter methods fail, most cardiologists suggest *coronary artery bypass graft surgery.* In bypass surgery, surgeons first remove a short piece of a blood vessel, usually a vein from the patient's leg or from an artery in the chest. They attach one end of the vessel to the aorta and the other end to the affected coronary artery, bypassing the blocked section. Surgeons can stop the heart to perform a bypass by using a *heart-lung machine.* The device has an electric pump and a system of membranes that do the work of the heart and lungs. The machine removes carbon dioxide from the blood and delivers oxygenated blood to the body tissues. A coronary bypass can ease symptoms of angina and prolong



Coronary bypass surgery enables blood to flow around blockages in coronary arteries. Such blockages, *top,* prevent blood from reaching the heart muscle. The surgeon uses short segments of veins from the patient's leg or arteries from the chest to construct bypasses around the blockages, *bottom.*

the lives of patients with more severe CAD. But it does not stop atherosclerosis.

Heart attack

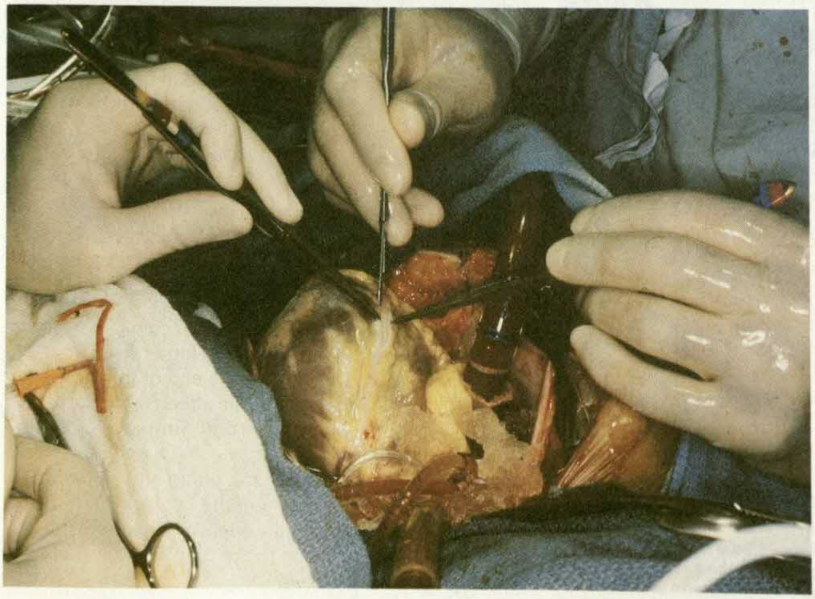
Almost all heart attacks occur when a blood clot suddenly and completely blocks a coronary artery. The condition is called a *coronary thrombosis,* or simply a *coronary.* The heart muscle supplied by the blocked artery becomes damaged because it receives too little oxygen. Unless blood flow returns within minutes, muscle damage increases. The heart cells begin to die after four to six hours without blood. The damage can affect the heart's ability to pump and cause the death of the victim. The body reacts to a heart attack with its own defences. Substances in the blood can dissolve clots and permit blood to flow freely again. If the clot is dissolved within four to six hours of the attack, the heart suffers less damage.

Symptoms. Before having a heart attack, many people suffer from angina, feel dizzy, have indigestion, or experience other symptoms. Some people have no warning signs. Most heart attacks cause severe pain. Victims describe the pain as a dull, crushing ache in the chest, but it may extend into the neck, jaw, arms, or back. The pain may last from a few minutes to several hours.

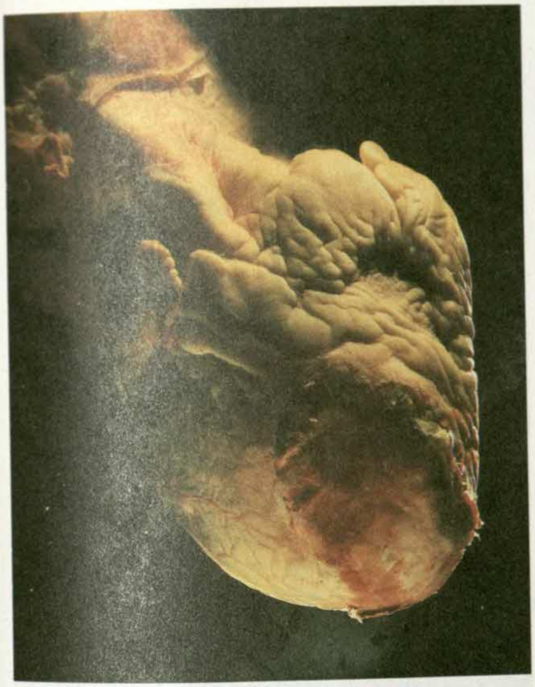
A person who has chest pain and suspects it may mean a heart attack should seek medical help immediately. Some victims may stop breathing, and their heart may stop beating. A first-aid technique called *cardiopulmonary resuscitation* (CPR) can maintain a person's breathing and circulation until medical help arrives and the victim is taken to a hospital. But cardiopulmonary resuscitation should be performed only by someone trained in the technique (see **Cardiopulmonary resuscitation**).

Diagnosis and treatment. Soon after a heart attack victim reaches the hospital, doctors use an ECG to make sure the patient actually had a heart attack and not chest pain resulting from some other disorder. Injured heart muscle causes abnormal ECG waves. Doctors also use certain blood tests to detect a heart attack. But the tests are not useful until six hours after the attack.

If a victim still has pain, doctors may administer a painkilling drug, such as morphine. They also use drugs to dissolve clots in the blocked artery. If the drugs fail to



During bypass surgery, doctors open the patient's chest and expose the heart, *left.* They then stop the heart and attach the new blood vessel segments to the blocked coronary arteries. A heart-lung machine pumps and oxygenates the patient's blood during surgery.



Heart attacks can cause severe damage to the heart muscle, *above.* The lighter areas are sections of muscle that were deprived of oxygen during an attack and can no longer function.

dissolve the clots, doctors may perform emergency angioplasty or bypass surgery.

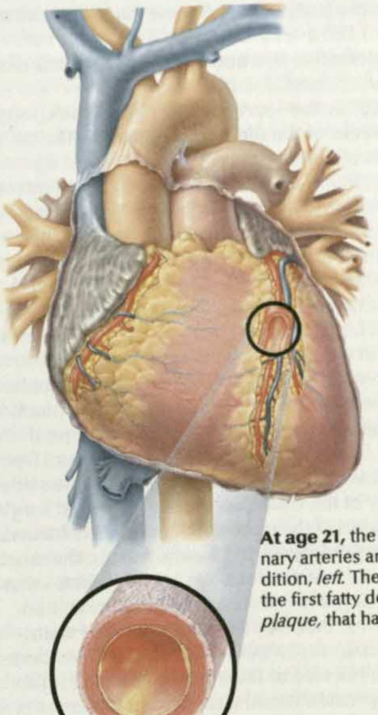
After being hospitalized, heart attack patients are monitored for complications in the *intensive care unit.* Two major complications are *heart failure* and *arrhythmia.* Heart failure occurs if the heart does not pump enough blood because of extensive damage to the heart muscle. In most cases, heart failure can be successfully treated. In arrhythmia, the heart's electrical system produces an abnormal rhythm. One kind of arrhythmia, *ventricular fibrillation,* occurs when electrical signals in the ventricles fire randomly. Ineffective heart rhythm and sudden death may result from ventricular fibrillation. Arrhythmias can be readily treated under medical care.

The death rate among heart attack victims who do not get medical care is more than 20 per cent. Some of them die before reaching a doctor. Other victims ignore their symptoms. The death rate among hospitalized patients ranges from 5 to 10 per cent. Heart attack patients with repeated chest pain, arrhythmias, or heart failure have a greater risk of another attack than do patients without those problems.

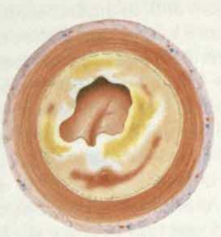
Recovery. Many doctors perform stress ECG's on patients who have had a heart attack to be sure no complications will occur. Patients with complications may be advised to consider angioplasty or bypass surgery. Those without complications are sent home for recovery and rehabilitation. Rehabilitation seeks to restore good health to patients through a programme that includes gradual increase in exercise, proper diet, and drugs to control such conditions as high blood pressure and high cholesterol. Most victims can do light work 30

Case history of a heart attack

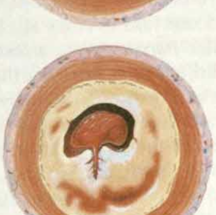
A heart attack occurs suddenly, but the factors that cause it take years to build up. Deposits in the coronary arteries begin early in life and eventually block the artery. These diagrams show one possible sequence of events leading to a heart attack.



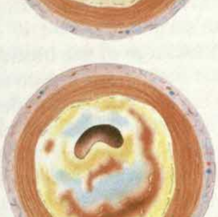
At age 21, the patient's coronary arteries are in good condition, *left.* The yellow area is the first fatty deposit, or *plaque,* that has formed.



At age 51, the coronary arteries are dangerously narrowed, *right.* Fatty deposits have reduced the artery opening to about one-fourth its original area.



At age 58, the artery is almost closed, *right.* A *thrombus* (blood clot) forms and blocks the artery, causing a heart attack.



At age 60, the patient has recovered. The artery has reopened after the heart attack, but the channel is much smaller in size, *right.*

days after an attack. Complete recovery of a heart with thick scars may take up to three months.

Birth defects

Cardiologists call any heart disorder present at birth *congenital heart disease.* Such disease happens in about 8 out of every 1,000 live births. Some defects are minor and permit a person to live normally. Other defects may be so severe they cause death.

Defects occur as the heart of a baby develops during the first few weeks of the mother's pregnancy. The unborn baby gets all its oxygen and nutrients from the mother's body. Blood circulates oxygen and nutrients through the baby's body to the right side of its heart. However, blood does not enter the infant's lungs because they cannot oxygenate it. Instead, blood travels from the pulmonary artery to the aorta through a channel called the *ductus arteriosus,* or simply *ductus.* The lungs begin to function at birth. The ductus closes, and blood begins to circulate to the lungs.

Most congenital heart defects are either abnormal openings in the heart or narrowed sections that block the flow of blood. The defects may produce unusual sounds called *heart murmurs* (see **Heart murmur**). Doctors do not know what causes most congenital heart defects, but many of the disorders can be corrected surgically. A discussion of the most common defects follows.

Abnormal openings in the heart. Among the most severe congenital heart defects are *septal defects*—that is, holes in the septum. A hole between the atria is an *atrial septal defect* (ASD), and one between the ventricles is a *ventricular septal defect* (VSD). The holes cause blood from the left side of the heart to enter the right side. Such oxygenated blood circulates to the lungs again and, in time, creates congestion in the lungs. Surgeons can correct both defects. VSD's are more serious than ASD's because of the extremely high pressure in the left ventricle. Some ASD's may not be detected until later in life, when blood pressure increases. If a large VSD is not corrected before a child is 2 years old, the lungs may be damaged, causing disability and premature death.

Another abnormal opening results if the ductus arteriosus fails to close at a baby's birth. The defect is called *patent ductus arteriosus* (PDA). In an unborn child, blood flows from the pulmonary artery to the aorta. If the newborn baby's ductus stays open, the blood flow reverses and runs from the higher-pressured aorta to the pulmonary artery. As with VSD, oxygenated blood returns to the lungs, causing congestion. Death may result unless the ductus is closed. Doctors administer drugs to close it. If drugs fail, PDA can be corrected with surgery.

Blockage of the blood flow is a common congenital heart defect. One reason for the blockage may be that the aortic valve has two flaps instead of three. Cardiologists call the disorder *bicuspid aortic valve.* Two flaps partly block the flow of blood, resulting in heart murmur. The defect usually presents no serious problem until adulthood, when surgery is required.

Another birth defect is a narrowing of the aorta where it descends to the lower body, a condition called *coarctation of the aorta.* The narrowing of the aorta may cause sudden heart failure in infants. In older children, the defect causes high blood pressure in the arms and head but low blood pressure in the legs. Surgeons usually correct the defect in late childhood, when the aorta is near full size.

Rehabilitation for heart attack victims begins in hospital. Many patients have *stress ECG*s, *above,* before they go home. This test can show the damage the heart has sustained.

An especially complicated congenital heart defect is *tetralogy of Fallot,* named after Étienne-Louis Fallot, a French doctor who first described the condition. The defect is actually a combination of four disorders—a *tetralogy.* The most serious disorders are a VSD—that is, a hole between the ventricles—and a narrowing of the pulmonary valve. The narrowed valve reduces the blood flow to the lungs, increasing pressure in the right ventricle. Blood from the right ventricle passes through the VSD to the left ventricle and returns to the body. Because that blood has not flowed through the lungs and picked up the red colour of oxygenated blood, it makes the skin appear bluish. Babies who have the defect are called *blue babies.* Some blue babies can be treated with drugs, but most of them need surgery to correct the condition. See **Blue baby.**

Other heart disorders

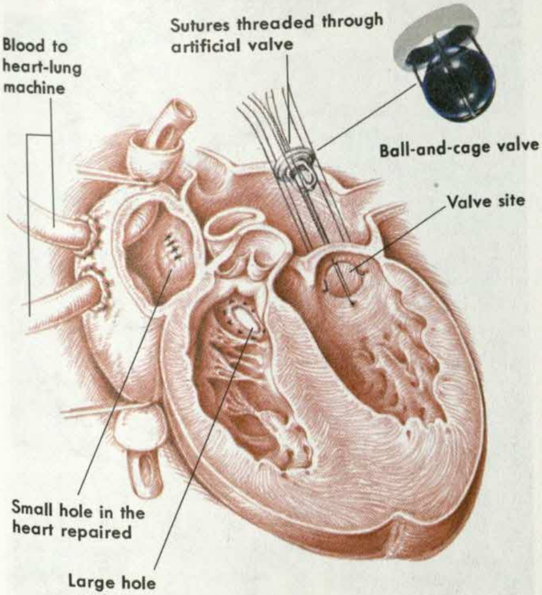
Valvular disease develops if the flaps of the heart valves become scarred or deformed. There are two main valve disorders. *Stenosis* occurs if the flaps harden and narrow the valve opening, which may reduce the flow of blood through the valve. *Regurgitation,* also called *insufficiency,* arises if the flaps close improperly, permitting blood to leak back into the chamber it came from. Valve disorders may not appear until adulthood, after years of wear on the deformed valve begin to affect its function.

Most valve disorders result from a congenital heart defect, such as an aortic valve with two instead of three flaps, or from *rheumatic fever.* Rheumatic fever involves bacterial infection followed by inflammation of many body tissues, including the heart. In some cases, rheumatic fever leads to *rheumatic heart disease,* which may cause permanent heart damage or death. Rheumatic fever typically occurs in childhood, but the heart problems it can lead to may not appear until victims are adults. Doctors try to prevent rheumatic heart disease by diagnosing and treating the original infection quickly. See **Rheumatic fever.**

Rheumatic heart disease usually inflames valve tissue, especially the mitral valve. The flaps thicken, causing regurgitation of blood through the valve. After the inflammation clears, scars form on the valve and cause both stenosis and regurgitation.

Symptoms of valvular disease include shortness of breath on exertion, tiredness, continual cough, and occasional chest pains. Doctors can diagnose valve disorders by detecting heart murmurs, which result from irregular blood flow. Regurgitation or the slowed passage of blood through a narrowed valve produce the irregular flow.

Doctors use several methods to prove their diagnoses and to determine the seriousness of valvular disease. A technique called *echocardiography* sends ultrasound waves through the chest. The sound waves reflect off the heart, and the returning echoes are transformed into a video image of the heart's valves and other structures. Doctors also use the technique to detect irregular blood flow, coronary artery disease, and other heart conditions. If echocardiography still leaves doubt about the existence of valvular disease, doctors perform cardiac catheterization along with coronary and cardiac angiography.


Blood to heart-lung machine
Sutures threaded through artificial valve
Ball-and-cage valve
Valve site
Small hole in the heart repaired
Large hole patched

Repairing heart defects. The illustration above shows three procedures for repairing heart defects. A surgeon mends a small hole in the heart by sewing the edges together, *left.* A larger hole is patched with synthetic fabric, *centre.* A faulty valve is removed and replaced with a ball-and-cage valve, *right.* The surgeon threads sutures around the valve site and through the artificial valve, slips the valve into place, and sews it to the heart.

Doctors closely watch patients with diseased valves for any changes in symptoms. If the disorder worsens, regurgitation and stenosis may cause *congestive heart failure,* a condition in which the heart cannot pump enough blood. Doctors treat congestive heart failure several ways. They ask patients to rest frequently, lose weight, or follow other advice intended to reduce the heart's workload. Doctors may prescribe digitalis or certain other drugs to improve the heart's pumping ability.

If the various methods of valve treatment fail, doctors operate to repair or replace the valve. A diseased mitral valve often must be replaced with an artificial valve. Surgeons use several types of artificial valves. One type, the *ball-and-cage valve,* consists of a stainless-steel cage that encloses a ball made of heat-treated carbon. Another replacement valve comes from a pig's heart. It works much like a human heart valve.

Abnormal heart rhythms may be harmless, or the arrhythmias may lead to death. An ECG can detect most abnormal rhythms. An arrhythmia slower than 60 beats per minute is a *bradycardia.* One faster than 100 beats per minute is a *tachycardia.*

A bradycardia may result from disease or drugs that slow the heart's natural pacemaker, which sets the heart rate by means of rhythmic electrical signals. Blockage of the electrical signal along the heart's conducting pathways produces a bradycardia called *heartblock.* If heartblock cannot be treated in any other way, doctors insert an electronic *artificial pacemaker* near the heart. The battery-operated device delivers an electrical signal to the heart and can be programmed for different rates.

A tachycardia occurs if disease causes the atria or ventricles to send electrical signals rapidly. Atrial tachycardias are relatively easy to treat. But ventricular tachycardias may lead to *fibrillation,* in which the irregular contractions cause sudden death. Several drugs can check tachycardias. If drugs fail to work on the ventricles, doctors can insert an electrical device similar to a pacemaker to overcome the fibrillation. The device, called a *defibrillator,* has an electrical pole placed on each side of the heart. The defibrillator senses when a ventricular tachycardia occurs and delivers a small shock to stop it.

Inflammatory heart disease, which involves swelling, heat, and pain, can strike various parts of the heart. *Pericarditis* is inflammation of the pericardium, the membrane that surrounds the heart. It can result from many disorders, infectious diseases, arthritis, or kidney failure. Pericarditis may cause fluid to collect under the pericardium. If too much fluid accumulates, the pericardium so compresses the heart that it cannot pump enough blood to the body. The condition may cause death unless doctors drain the fluid with a needle pushed through the chest and into the pericardium. Repeated inflammation can scar the membrane and squeeze the heart. If this occurs, surgeons remove the scar tissue.

The endocardium, the membrane that lines the heart's chamber and makes up its valves, becomes inflamed in a disease called *bacterial endocarditis.* The condition arises when bacteria enter the bloodstream from parts of the body where they normally grow and infect the heart. For example, bacteria from the mouth may enter the blood during dental surgery. In most people, normal body defences destroy such bacteria. But in patients with valvular disease, bacteria may collect on the abnormal valve and grow. Bacterial endocarditis is fatal unless it is treated with antibiotics. Doctors give such germ-killing drugs before and after surgery to patients who are easily infected.

Inflammation of the myocardium, the muscle tissue that forms the heart's walls, is called *myocarditis.* If the inflammation damages the muscle cells beyond repair, the patient may require a heart transplant.

Cardiomyopathy refers to any of various diseases of the heart muscle itself. Cardiomyopathy may develop on its own or be caused by other disorders. The disease has two general forms. In *hypertrophic cardiomyopathy,* the heart muscle tissue grows improperly. In *congestive cardiomyopathy,* the heart muscle is weakened and causes heart failure.

Most cases of hypertrophic cardiomyopathy involve thickening of the muscular wall between the heart's two lower chambers. The thickened septum blocks blood flowing from the left ventricle, causing lung congestion. The condition can be treated with drugs that relax the heart and lessen the ability of the extra tissue to block the flow of blood. But if the disease becomes severe, surgeons must cut out the abnormal muscle.

Congestive cardiomyopathy occurs if heart muscle weakness causes the left ventricle to enlarge, resulting in inadequate pumping. In most cases, doctors do not know the cause of congestive cardiomyopathy. They have no specific treatment for the condition but may prescribe certain drugs and restrict a patient's activities to slow the progress of the disease. Some patients may need a heart transplant.

Heart failure is a disorder in which the heart pumps inefficiently. It does not mean the heart stops beating. Any disease that hampers the heart's ability to deliver blood to the body may cause the condition. Most cases of heart failure result from coronary artery disease, cardiomyopathy, and valvular disease. The inadequate blood flow produces exhaustion. In addition, the poor blood flow makes the blood back up in the lungs. The congestion causes shortness of breath.

The body's attempts to overcome heart failure only worsen the condition. For example, the body tries to maintain blood flow to the brain and other vital organs by narrowing the arteries to such parts as the arms and legs. But the contraction makes it harder for the heart to pump. Doctors prescribe drugs to eliminate the problem.

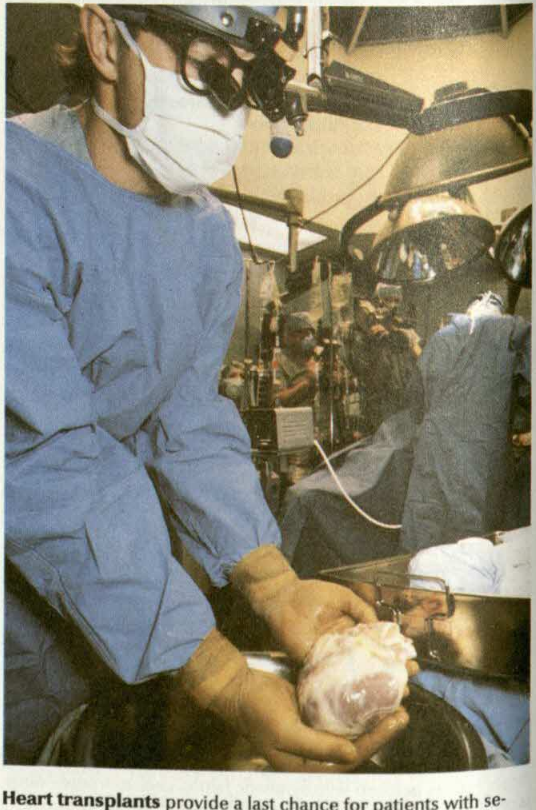
The oldest medicines to treat heart failure are digitalis drugs. Doctors have prescribed digitalis for certain heart conditions for more than 200 years. Digitalis strengthens the heart's contractions, thus increasing blood flow. Much newer drugs called *vasodilators* block the body's natural but undesirable response to tighten the arteries when heart failure occurs. Some vasodilators relax the smooth muscle in the blood vessel walls. Others block the chemical reactions that cause smooth muscle contraction in the artery walls.

If drugs cannot control heart failure, the patient may need surgery to correct any mechanical problem that led to the disorder. But surgery presents a high risk for dangerously ill patients who do not respond to drugs. Such patients may be hooked up to temporary *cardiac assist devices,* which are small pumps attached to the veins and arteries. The devices help the heart work and enable surgeons to repair the mechanical problem.

If the heart has no correctable mechanical problem, surgeons may perform a heart transplant. They remove the heart from a dead person—preferably a beating heart from a person declared brain dead—and put it in the place of a patient's diseased heart. However, the patient's body may reject the new heart because the body naturally destroys any foreign tissue that enters it. Doctors try to prevent rejection with powerful drugs, but the drugs may have serious side effects. A shortage of donor hearts presents another problem. Many patients who need a transplant die waiting for a suitable donor heart. See **Tissue transplant.**

The survival rate of heart transplant patients in the first year is about 80 per cent. However, survival requires extensive care, involving close medical supervision, and constant medication.

During the 1980's, surgeons experimented with implanting artificial hearts in people. However, the devices



Heart transplants provide a last chance for patients with severe cardiac damage. A surgeon cradles a donor heart in his hands in the operating room scene above.

proved unsuccessful because they tended to form blood clots. See **Artificial heart.**

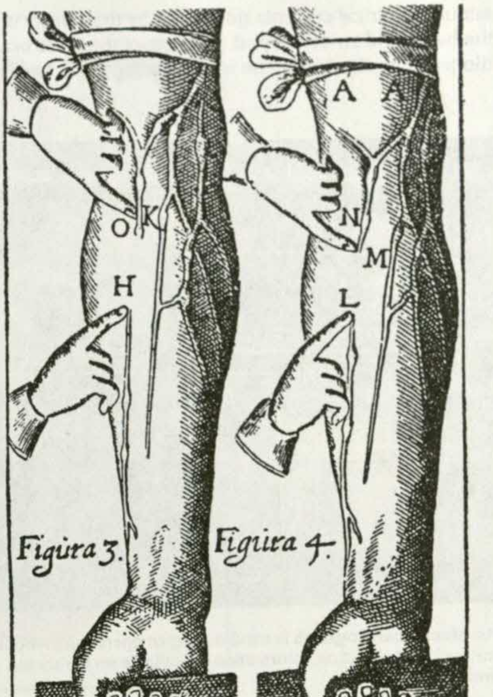
History of heart research

Early beliefs about the heart. In ancient times, many people believed that the heart had special importance. For example, the Chinese thought that each emotion originated in a certain organ and that happiness dwelt in the heart. Chinese doctors diagnosed many illnesses and prescribed treatment after taking the pulse at the wrist. The ancient Egyptians considered the heart to be the source of intelligence and emotion.

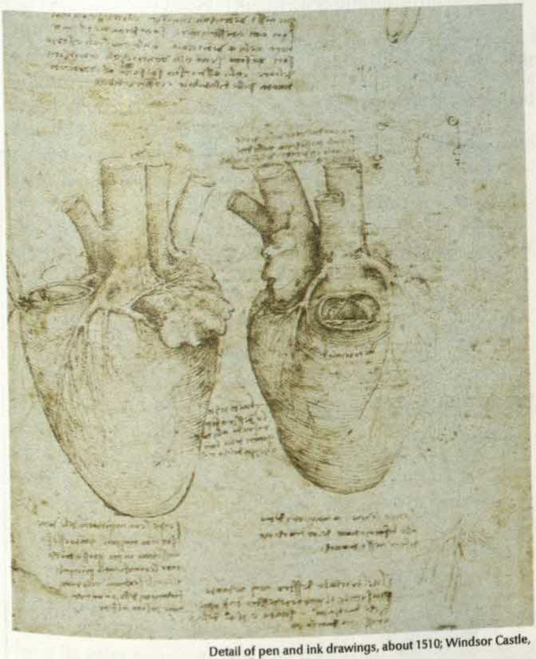
The ancient Greeks learned from battlefield injuries and animal sacrifices that the heart was a beating organ. In the A.D. 100's, the Greek doctor Galen developed the first medical theories based on scientific experiments. Galen observed the heartbeat and realized that the heart put blood in motion. But he thought that the heart's right ventricle forced blood into the left ventricle through holes in the septum. Galen also believed that the liver converted food into blood, which then flowed through the body and was used up. See **Galen.**

Discovery of circulation. Doctors accepted Galen's theories—in spite of the many errors—until the 1500's. In the mid-1500's, a Flemish-born doctor named Andreas Vesalius described blood vessels. He also showed that no holes exist between the heart's chambers. Also in the 1500's, Michael Servetus, a Spanish doctor and theologian, reasoned that blood flows between the heart and lungs. But his studies were not publicized because of his unpopular religious beliefs.

The theory of blood circulation was first published in 1628, by William Harvey, an English doctor. His work became the basis of modern research on the heart and blood vessels. Harvey showed that the heart works like a pump. He described how blood flows from the heart to the lungs, back to the heart, out to the body, and back to the heart. Harvey believed that small blood vessels called *capillaries* connect arteries and veins. The idea of capillaries had been proposed in the 1500's by an Italian anatomist named Andrea Cesalpino. Marcello Malpighi, an Italian doctor, proved their existence in 1661. In the early 1700's, Stephen Hales, an English clergyman and scientist, became the first person to measure blood pressure. He placed a glass tube in a horse's artery after breaking through the animal's skin. Hales published the result of this experiment in 1733.



William Harvey showed that the heart worked like a pump. His illustrations, such as the woodcut above, detailed how blood circulated to all parts of the body.

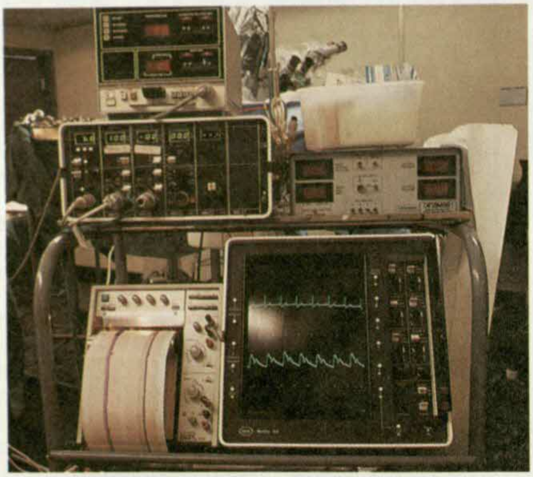


Detail of pen and ink drawings, about 1510; Windsor Castle, England

Leonardo da Vinci made detailed drawings of the heart's anatomy during the early 1500's. His accurate sketches helped call into question some accepted beliefs about the heart's structure.

Invention of new medical instruments. During the 1800's, many inventions expanded doctors' knowledge of the heart and helped in their diagnosis and treatment of heart problems. In 1816, a French doctor named René Laënnec invented the stethoscope, which enabled doctors to listen to sounds of the heart and other organs. In 1880, Samuel Siegfried von Basch, a Viennese doctor, developed the *sphygmomanometer,* an instrument to measure blood pressure without breaking the skin. Russian doctor Nikolai Korotkoff used a stethoscope in 1905 to take the pulse while measuring blood pressure, thus recording systolic and diastolic blood pressure. Doctors still use this technique.

In 1903, Willem Einthoven, a Dutch physiologist, invented the *string galvanometer,* a device to measure minute electrical currents generated by the activity of the heart, and so developed the basis of the electrocardiograph. By the 1920's, the electrocardiograph had become the chief diagnostic tool in cardiology.



An electrocardiograph is used during an operation to monitor the heart's function. Information is available on the screen and as a printout.

Earlier, chest X-rays had provided the first images of the living heart. A means of viewing the interior of its chambers came with the development of cardiac *catheterization* in 1929. The pioneer was a young German doctor, Werner Forssmann, who experimented on himself. Passing a rubber catheter into the right atrium of his own heart, Forssmann produced the first *cardioangiograms* (X-ray images of the chambers of the heart and great vessels). Forssmann shared the 1956 Nobel prize for medicine for his outstanding contribution to diagnostic cardiology.

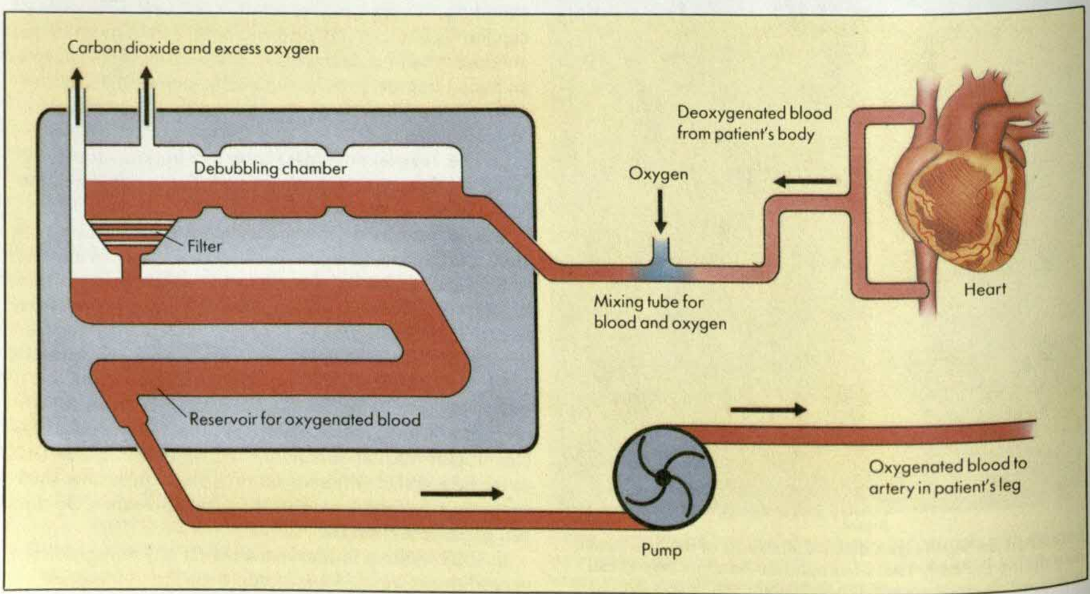
Development of heart surgery. In 1897 doctors placed stitches in the living heart for the first time. A German surgeon called Ludwig Rehn operated to save the life of a man who had been stabbed accidentally in the heart. But surgery did not become an option for heart disease until the late 1930s, when Robert E. Gross, an American surgeon, performed the first successful repair of a congenital heart defect. Gross sewed the hole in the artery of a child suffering from patent ductus arteriosus.

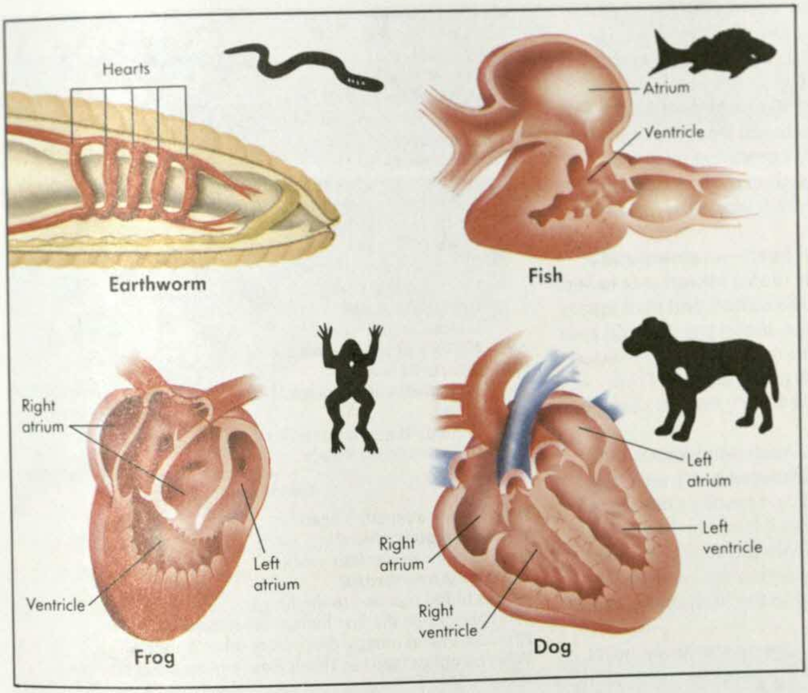
In 1944, Helen Brooke Taussig and Alfred Blalock, two American doctors, developed an operation to help correct abnormal circulation of blue babies.

At first surgeons performed all cardiac surgery with the heart still beating. This meant the surgeon had to work quickly and was very limited in what he could see or do. This all changed when, in 1953, another American surgeon, John H. Gibbon, and his associates successfully used the heart-lung machine which they had developed. Using this machine during an operation enabled doctors to stop the heart while the device pumped and oxygenated the blood. Doctors could then repair defects while the heart was still.

This led to two kinds of operations: the correction of structural heart defects in children and the replacement of diseased heart valves in adults. Much later, open-

The development of the heart-lung machine in the 1950's made open-heart surgery possible. The machine removes carbon dioxide from the blood and adds oxygen, as the lungs do. It then pumps the oxygenated blood back to the body, usually through an artery in the leg. From there the blood enters a major branch of the aorta and then circulates to the body tissues, without flowing through the heart.


Carbon dioxide and excess oxygen
Debubbling chamber
Filter
Reservoir for oxygenated blood
Pump
Oxygen
Mixing tube for blood and oxygen
Deoxygenated blood from patient's body
Heart
Oxygenated blood to artery in patient's leg



Animal hearts vary in size and complexity. Earthworms, like most animals without a backbone, have contracting blood vessels that function as "hearts." Fish have a two-chambered heart, while frogs and other amphibians have a three-chambered type. Dogs, like all mammals, have a four-chambered heart, as do birds.

heart surgery was extended to coronary artery disease. The coronary bypass operation was perfected in the late 1960's by René Favaloro, an Argentine doctor working in the United States. In 1967, American surgeons Michael DeBakey and Adrian Kantrowitz successfully implanted the first *assisting heart.* This device temporarily helped a diseased or overworked left ventricle.

The first heart transplants. A team of South African surgeons headed by Christiaan Barnard performed the first human heart transplant in 1967. The patient lived 18 days and died of a lung infection.

In the late 1960's and early 1970's, doctors performed many heart transplants. But most patients died within a year, mainly because the body rejected the new organ. Doctors almost stopped doing heart transplants. Then in the 1980's, they began using a drug called *cyclosporin* to fight rejection. Cyclosporin greatly increased the survival rate among transplant patients. The shortage of donor hearts has become the chief obstacle to successful heart transplants today.

Progress in treatment and prevention occurred about the same time as the dramatic advances in heart surgery. In the late 1960's, researchers developed beta-blockers. These drugs help in reducing high blood pressure, preventing angina, and controlling certain arrhythmias. Calcium channel blockers, which work like beta-blockers, appeared in the 1970's.

In 1977, a Swiss doctor named Andreas Gruentzig performed the first angioplasty, a nonsurgical procedure to open a blocked artery. Researchers also developed various techniques to use with angioplasty to prolong its effectiveness. The first implantable defibrillator became available in 1985. The device senses excessive contractions of the ventricles and sends a small electrical shock to stop them.

Meanwhile, prevention of heart disease has centred on eliminating controllable risk factors. High blood pressure, high blood cholesterol, and cigarette smoking are major causes of CAD. Removal of those risk factors may prevent the development of the disease.

Much of what has been learned about preventing heart disease comes from extensive medical research. For example, the Framingham Heart Study has provided considerable knowledge about the risk factors involved in coronary artery disease. The study began in 1948 in Framingham, Massachusetts, and has examined the functioning of the heart in more than 5,000 people. Such research has led scientists to develop new drugs to treat high blood pressure and high cholesterol.

Many people have improved the condition of their heart by learning the value of preventive medicine. For example, they have their blood pressure and cholesterol level checked regularly. Many people with mild high blood pressure have reduced it by limiting the salt and calorie content of their diet. Others have lowered their cholesterol level by watching the amount of cholesterol, saturated fat, and calories in their diet. In addition, more and more people exercise regularly, which helps keep body weight down and so helps lower cholesterol and blood pressure.

Hearts of animals

Animals without a backbone. Most animals without a backbone lack a definite heart. Instead, large blood vessels contract rhythmically, pushing blood through the body. The blood vessels have valves, and so blood flows in only one direction. Animals with such circulation include earthworms. Insects and such animals as spiders, lobsters, and crabs have a one-chambered, tubular heart in which blood flows through holes into the heart. The heart then contracts, sealing the holes, and pumps blood forward into the arteries. Molluscs, such as clams, oysters, and snails, have a more complicated heart with one or more atria and a ventricle. This heart is an enlarged section of the circulatory system. The atria, which have thin walls, receive blood from the digestive system and from the mollusc's burrowing muscular organ called the *foot.* The atria then pump blood into the thicker-walled ventricle, which sends the blood to the arteries.

Fish have a two-chambered heart—an atrium and a ventricle. Blood from the body drains into an area called the *sinus venosus,* flows into the atrium, and then enters the ventricle. From the ventricle, blood passes to an area called the *conus arteriosus* and then to the aorta. Blood is then pumped from the aorta to the arteries. From there, blood goes to the gills, where it receives oxygen and gives off carbon dioxide.

Amphibians and reptiles. Adult amphibians and most reptiles have a three-chambered heart, with two atria and one ventricle. One atrium receives blood from the body, and the other receives it from the lungs. Both streams of blood are pumped into the ventricle. When the ventricle contracts, a ridge within the ventricle directs most of the arterial blood to the body and most of the venous blood to the lungs.

Birds and mammals have a four-chambered heart. The human heart is a typical mammalian heart. The four-chambered heart is the most highly developed type of heart. Within the heart are two types of circulation. *Pulmonary circulation* sends blood to the lungs, and *systemic circulation* delivers oxygenated blood to the body. Such a circulatory system is exceptionally efficient at pumping blood and can do so at high pressure.

A bird's or mammal's heart rate depends on the animal's size. The smaller the animal is, the faster its heart rate is. For example, a hummingbird has a heart rate of about 1,000 beats per minute. An elephant's heart beats about 25 times a minute.

Related articles in *World Book* include:

Aneurysm
Angina pectoris
Angiography
Angioplasty
Aorta
Arrhythmia
Arteriosclerosis
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Beta-blocker
Blood
Blood pressure
Blue baby
Calcium channel blocker
Capillary
Cardiology
Cerebral haemorrhage
Circulatory system
Coronary thrombosis
DeBakey, Michael
Disease (graph)
Drug (Drugs that affect the heart and blood vessels)
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Embolism
First aid (Heart attack)
Fluoroscopy
Harvey, William
Heart murmur
Human body (Trans-Vision)
Hypertension
Laënnec, René T.H.
Myocarditis
Pulse
Rheumatic fever
Smoking
Stethoscope
Stroke
Tachycardia
Taussig, Helen B.
Vein
Williams, Daniel H.

Outline

I. The structure of the heart
  A. Muscular walls
  B. Chambers
  C. Blood vessels
  D. Valves
II. The work of the heart
  A. Pumping blood to the lungs
  B. Pumping blood throughout the body
  C. Regulating the heart rate
  D. Regulating blood pressure
III. Coronary artery disease
  A. Risk factors
  B. Causes
  C. Symptoms and diagnosis
  D. Treatment
IV. Heart attack
  A. Symptoms
  B. Diagnosis and treatment
  C. Recovery
V. Birth defects
  A. Abnormal openings in the heart
  B. Blockage of the blood flow
VI. Other heart disorders
  A. Valvular disease
  B. Abnormal heart rhythms
  C. Inflammatory heart disease
  D. Cardiomyopathy
  E. Heart failure
VII. History of heart research
VIII. Hearts of animals
  A. Animals without a backbone
  B. Fish
  C. Amphibians and reptiles
  D. Birds and mammals

Questions

How large is a person's heart?
What are *septal defects*?
How does an *angioplasty* work?
What is *atherosclerosis*?
Why is blood pumped to the lungs?
Who performed the first human heart transplant?
How does heart muscle differ from other muscles?
What complications can result from a heart attack?
What is the chief obstacle to successful heart transplants today?
How do doctors perform a *coronary bypass*?

Heart attack. See **Heart** (Heart attack); **First aid** (Heart attack).

Heart diseases. See **Heart** (Heart diseases).

Heart murmur is an abnormal sound in a person's heartbeat. An *organic murmur* is a symptom of heart disease. It is produced as the blood flows through defective heart valves or across defects between chambers of the heart. A diseased heart valve may not close tightly or open completely when the heart contracts, and the forceful passage of blood around the valve causes a murmur. Causes of organic murmur include (1) rheumatic fever, (2) heart deformities present at birth, and (3) *arteriosclerosis* (hardening of the arteries). A *functional murmur,* also called an *innocent murmur,* occurs in the absence of heart disease. It may appear after a person exercises strenuously.

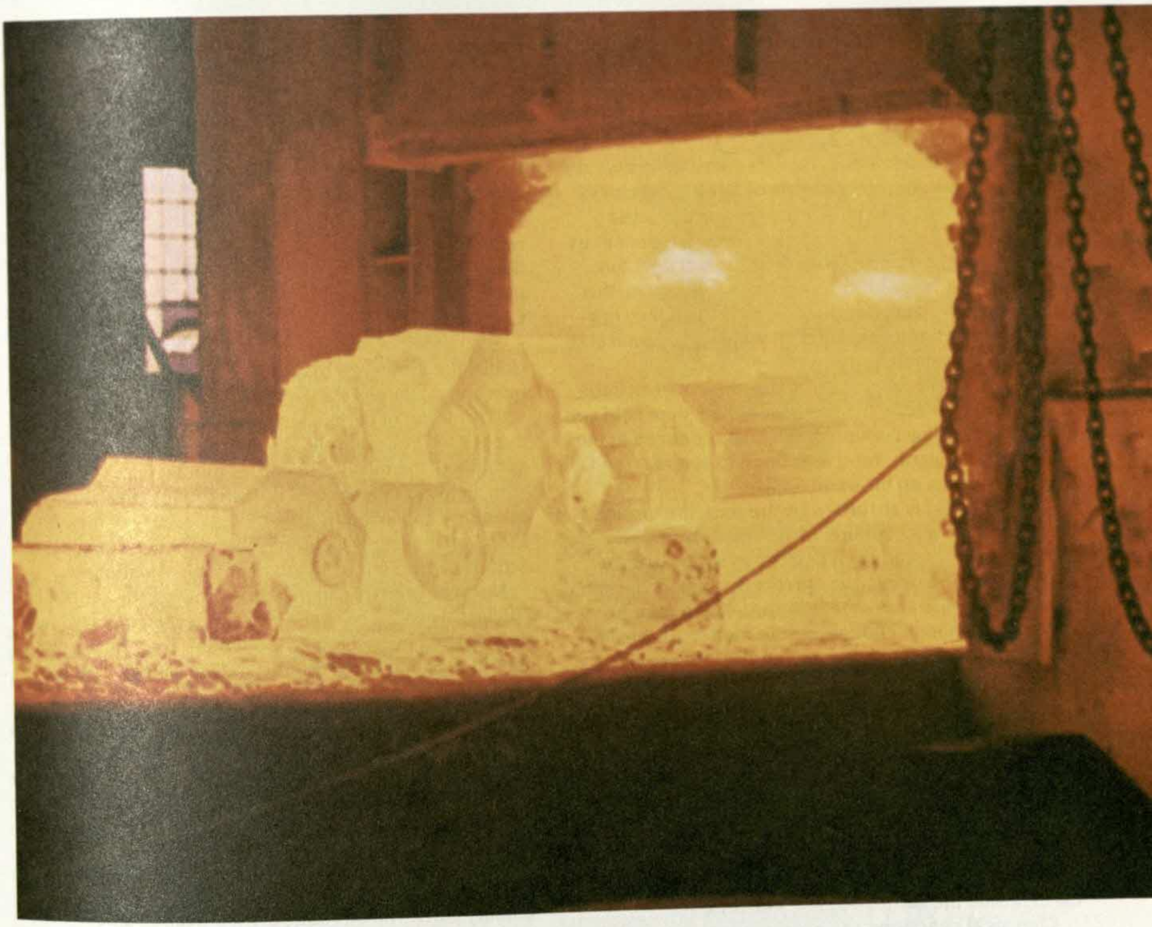
Heartburn, also known as *pyrosis,* is a painful, burning sensation in the oesophagus. Heartburn results when acidic stomach contents surge upward into the oesophagus or when the oesophagus undergoes intense spasms. Heartburn usually begins just below the tip of the breastbone, near the heart, and rises toward the throat. In some cases, the mouth suddenly fills with a large amount of clear, watery saliva called *water brash.* The pain of heartburn may last several hours.

Heartburn accompanies many types of indigestion. It most frequently occurs after a person drinks a hot or cold liquid. People who are tense or tired may suffer from heartburn, especially after eating. Pregnant women and people who have ulcers or gall bladder disease may also experience heartburn. Antacid medications can temporarily relieve heartburn pain.

See also **Indigestion; Ulcer.**

Heartwood. See **Sap.**

Heartworm. See **Dog** (Medical care).



People use heat in many ways to do work and to make life more comfortable. In this foundry furnace, for example, heat is used to soften steel so that it can be shaped into the desired form. The steel becomes so hot it gives off light.

Heat

Heat is one of the most important forms of energy. When we think of heat, we usually think of how heat makes us feel. On a hot day, for example, it may make us feel uncomfortable. But heat is far more important in our lives than simply how it may make us feel.

We must have a carefully controlled amount of heat to live. Our bodies use the food we eat to produce the heat that keeps our body temperature at about 37° C. If our temperature rises too far above normal—or falls too far below—we can die. In cold weather, we wear heavy clothes to hold in our body heat. During warm weather, we wear light clothes to let the unneeded heat escape.

No one knows how high temperatures may climb, but the temperature inside the hottest stars is many millions of degrees. The lowest possible temperature, called *absolute zero,* is −273.15° C.

An object at a temperature of absolute zero would contain no heat at all. Physicists are not able to cool an object to the temperature of absolute zero, consequently, even the coldest objects contain some heat. See **Absolute zero.**

In our homes, we use heat in many ways. Heat warms our homes and cooks our food. It also provides hot water, dries the laundry, and makes electric light bulbs give off light.

In industry, the uses for heat are almost endless. Heat is used to separate metals from their ores and to refine crude oil. It is used to melt, shape, cut, coat, and harden metals and to join metals together. Heat is also used to make or process foods, glass, paper, textiles, and many other products.

Heat also runs our machinery. The heat from burning fuels in engines provides the power to move aeroplanes, cars, rockets, and ships. Heat causes the wheels of giant turbines to spin, driving generators that produce electricity. Electricity provides light and furnishes power to run all kinds of equipment—from electric pencil sharpeners to electric trains.

This article discusses where heat comes from and what heat is, how it travels, and what it does. The article also describes how we have put heat to work and the discoveries we have made about heat.

Sources of heat

Anything that gives off heat is a source of heat. The heat that we use or that affects life and events on the earth comes from six main sources. They are (1) the sun, (2) the earth, (3) chemical reactions, (4) nuclear energy, (5) friction, and (6) electricity.

We control some of these sources, and others we do not. We use the sources we control, such as electricity and nuclear energy, to heat buildings and do other work. But the sources we do not control also benefit us. For example, the sun provides the heat and light that make life possible. All sources of heat, even those that we normally control, can do great damage if they get out of control. For example, fires, which are chemical reactions, destroy much property every year.

The sun is our most important source of heat. If the sun should ever cool, the earth would become cold and lifeless. Only a tiny fraction of the heat produced in the sun strikes the earth. Yet it is enough to keep us—and all other organisms on the earth—alive.

The sun's heat is absorbed by the seas, the ground, plants, and the atmosphere. Large amounts of heat can be collected by using such devices as large *solar furnaces.* These furnaces have mirrors that reflect the sun's light from a wide area onto one spot. Some solar furnaces can generate enough heat to melt steel. Smaller ones can gather enough heat to cook food. See **Solar energy; Sun.**

The earth itself contains much heat deep inside. When a volcano erupts, some of this heat escapes to the surface. The lava from a volcano is rock melted by the heat deep within the earth. Some of the earth's heat also escapes in *geysers.* These springs shoot forth boiling water that has been heated by hot rocks within the earth. People have begun to use the earth's heat to generate electricity, heat houses, and do other work. See **Earth** (Inside the earth); **Geyser; Volcano.**

Chemical reactions can produce heat in a number of ways. A chemical reaction in which a substance combines with oxygen is called *oxidation.* Rapid oxidation produces heat fast enough to cause a flame. When coal, wood, natural gas, or any other fuel burns, substances in the fuel combine with oxygen in the air to form other compounds. This chemical reaction, which is known as *combustion*, produces heat—and fire.

People use fire in many ways. Fire in a gas stove produces heat to cook food. Coal, oil, or gas fires in furnaces and boilers heat buildings. Fire heats metals red-hot so that they can be shaped into a variety of forms. Special cutting torches can produce flames hot enough to cut through metal. See **Fire.**

Another example of combustion is the burning of petrol in the cylinders of a car engine. This process produces heat that causes the gases in the cylinders to expand and move parts that make the engine work. See **Combustion.**

The rusting of iron is also an example of oxidation. Unlike fire, however, rusting occurs so slowly that little heat and no flames are produced. See **Oxidation.**

The mixing of certain kinds of chemicals also produces heat. For example, if sulphuric acid and water are combined, the mixture becomes boiling hot.

In all living things, food is changed into heat—as well as energy and living tissue—by the process of *metabolism.* Metabolism is a complicated series of chemical reactions carried out by living cells. See **Metabolism.**

Nuclear energy can produce great quantities of heat. Nuclear weapons release so much heat so quickly that they destroy everything around them. Their heat cannot be put to useful work. But in a device called a *reactor,* heat can be produced from nuclear energy slowly enough to generate electricity and to do other jobs. See **Nuclear energy; Nuclear reactor.**

Friction. When one object rubs against another, heat is produced. Friction is usually an unwanted source of heat because it may damage objects. In a machine, for example, the heat created as the moving parts rub against one another may cause those parts to wear down. For this reason, oil is used between moving machinery parts. The oil reduces friction and so decreases the generation of heat. See **Friction.**

Electricity. The flow of electricity through metals, alloys, and other *conductors* (substances that carry or *conduct* electric current) generates heat. People make use of this heat in the operation of many appliances, including electric furnaces, ovens, ranges, dryers, heaters, toasters, and irons. See **Electricity.**

Sources of heat

The sun produces heat from nuclear reactions deep inside it. All life on the earth depends on this heat.

Friction—the rubbing of one object against another—produces heat. Scouts learn to start a fire with friction.

Chemical reactions produce heat by causing a chemical change in substances. Fire is a chemical reaction.

The earth contains much heat deep inside. Some of this heat escapes to the surface when a volcano erupts.

What heat is

Heat is a form of energy. Heat and energy cannot be seen, but the work they do can. For example, the burning of fuel in the engines of a jet aeroplane creates hot gases. These gases expand and provide the power that moves the plane. See **Energy.**

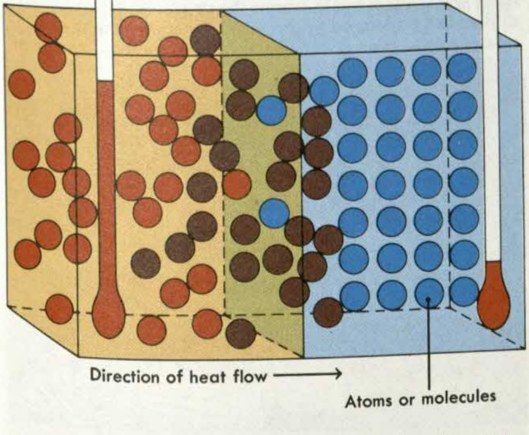
Temperature and heat. All things are made up of atoms or molecules, which are always moving. The motion gives every object *internal energy.* The *level* of an object's internal energy depends on how rapidly its atoms or molecules move. If they move slowly, the object has a low level of internal energy. If they move violently, it has a high level. Hot objects have higher internal energy levels than do cold objects. The words *hot* and *cold* refer to an object's temperature.

Temperature is an indication of an object's internal energy level. A thermometer is used to measure temperature. Thermometers have a numbered scale so that temperature can be expressed in degrees. The two most common scales are the *Celsius,* or *centigrade,* and the *Fahrenheit* scales. See **Temperature.**

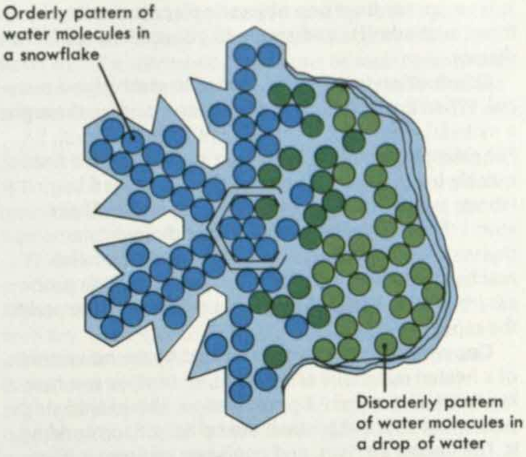
The temperature of an object determines whether that object will take on more internal energy or lose some when it comes into contact with another object. If a hot rock and a cold rock touch each other, some of the internal energy in the hot rock will pass into the cold rock as heat. If a thermometer were placed on the hot rock, it would show the rock's temperature falling steadily. A thermometer on the cold rock would show a steadily rising temperature. Eventually, the thermometers on the two rocks would show the same temperature. Then, no further flow of heat would occur.

Just as water flows only downhill, so heat flows only down a "temperature hill," passing from an object at a higher temperature to an object at a lower one. The greater the difference in temperature between two objects, the faster the heat will flow between them.

It is important to recognize that temperature and heat are not the same thing. Temperature is simply an indication of the level of internal energy that an object has. Heat, on the other hand, is the energy passed from one object to another.



Heat energy flows from a hot to a cold object when they are in contact. The rapidly moving atoms or molecules in the hot object strike the less energetic atoms or molecules in the cold object and speed them up. In this way, internal energy in the form of heat passes from a hot object to a cold object.


Orderly pattern of water molecules in a snowflake
Disorderly pattern of water molecules in a drop of water

Heat decreases the orderly arrangement of the atoms or molecules in an object. For example, the molecules of water in a snowflake are frozen in an orderly pattern. But as heat flows into the flake, its molecules move more rapidly. They become so disorderly that the snowflake begins to melt.

The three units most commonly used to measure heat are calories, joules, and British thermal units (Btu's). One *calorie* is the quantity of heat needed to raise the temperature of 1 gram of water 1° C. The calorie used to measure food energy is 1,000 times as large as this calorie. One *Btu* is the quantity of heat needed to raise the temperature of 1 pound of water 1° F. The Btu is often used in engineering, and the calorie in the sciences. The *joule* can be used for measuring all forms of energy, including heat. One joule is the amount of energy used—or work done—when a force of 1 newton moves an object 1 metre in the direction of the force. See **British thermal unit; Calorie; Joule; Newton.**

Disorder. Temperature and internal energy tell only part of the story about heat. To tell the whole story, we need to see what happens to the atoms or molecules of an object when heat flows into it.

As heat enters an object, that object's atoms or molecules move around more. The more heat that flows in, the more the object's atoms or molecules move around and the more disorderly they become. For example, the water molecules in a snowflake have an orderly pattern. But if a snowflake is taken into a warm room, it will melt and become a drop of water. Heat changes the orderly pattern of the snowflake into disorder. Scientists use the term *entropy* to describe the amount of disorder in an object. See **Entropy.**

Heat flowing into an object increases the internal energy and disorder in that object. Usually, the added heat also raises the temperature of the object. On the other hand, heat flowing out of an object decreases the internal energy and disorder in that object. Usually, the heat loss also lowers the temperature of the object.

How heat travels

Heat passes from one object or place to another by three methods: (1) conduction, (2) convection, and (3) radiation.

Conduction is the movement of heat through a material. When heat travels by conduction, it moves through a material without carrying any of the material with it. For example, the end of a copper rod placed in a fire quickly becomes hot. The atoms in the hot end begin to vibrate faster and strike neighbouring atoms. These atoms then vibrate faster and strike adjoining atoms. In this way, the heat travels from atom to atom until it reaches the other end of the rod. But during the process, the atoms themselves do not move from one end to the other.

Convection is the transfer of heat by the movement of a heated material. For example, a hot stove in a room heats the air around it by conduction. This heated air expands and so is lighter than the colder air surrounding it. The heated air rises, and cooler air replaces it. Then the cooler air near the stove becomes warm and rises. This movement of heated air away from a hot object and the flow of cooler air toward that object is called a *convection current.* The current of air carries heat to all parts of the room.

Convection occurs in liquids as well as in gases. For example, convection currents will form in a pan of cold water on a hot stove. As the water near the bottom of the pan warms up and expands, it becomes lighter than the cold water near the top of the pan. This cold water sinks and forces the heated water to the top. The convection current continues until all the water reaches the same temperature.

Radiation. In conduction and convection, the motion of particles transmits heat. But in radiation, heat can travel through a vacuum, which has no particles. In any object, the moving atoms or molecules create waves of radiant energy. These waves are also called *infrared rays.* Hot objects give off more infrared rays than do cold objects. Infrared rays travel through space in much the same way as water waves travel on the surface of a pond. When the radiant energy strikes an object, it speeds up the atoms or molecules in that object. Energy from the sun travels through space to the earth. These rays warm the earth's surface. See **Infrared rays.**

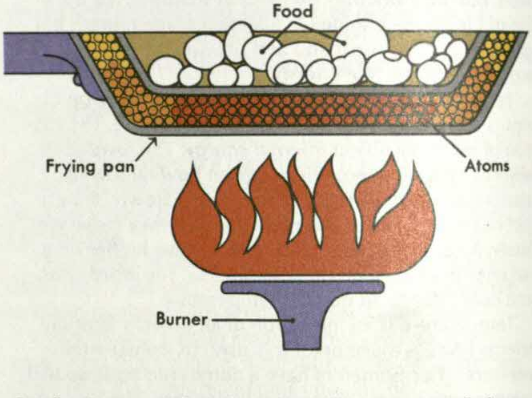
Insulation is a way to control the movement of heat by keeping it in or out of a place. For example, houses are insulated to keep the heat inside in winter and outside in summer. People use three methods of insulation because heat can travel in any one of three ways.

Certain materials, such as plastic and wood, are good insulators against the movement of heat by conduction. This is why many pots and pans have plastic or wood handles. The metal utensil itself heats rapidly by conduction, but the handle stays cool.

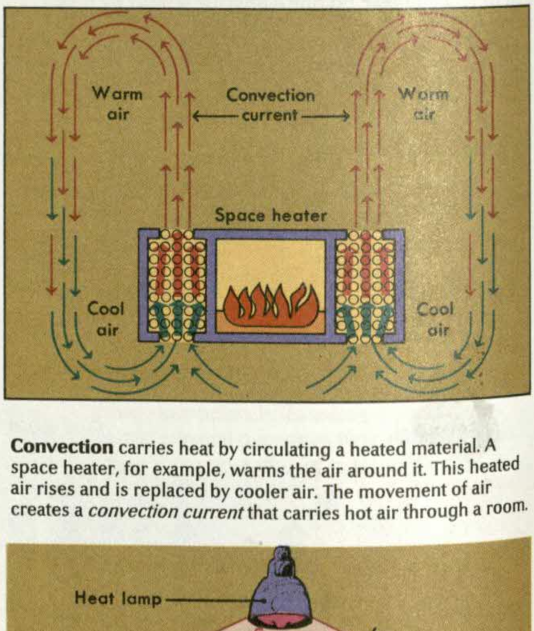
The movement of heat through the air by convection can be controlled by blocking the space between a hot and cold area with "dead air." For example, the layer of air between a storm window and the inner window acts as an insulator.

Surfaces that reflect infrared rays can insulate heat travelling by radiation. For example, shiny metal roofs reflect the sun's rays. See **Insulation.**

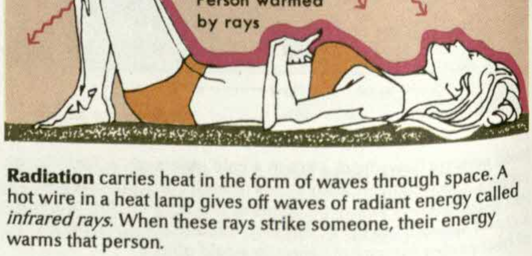
How heat travels



Conduction carries heat through an object. For example, heat from a burner makes the atoms on the underside of a frying pan vibrate faster. These atoms then strike atoms above them. In this way, heat passes through the pan to the food inside it.



Convection carries heat by circulating a heated material. A space heater, for example, warms the air around it. This heated air rises and is replaced by cooler air. The movement of air creates a *convection current* that carries hot air through a room.



Radiation carries heat in the form of waves through space. A hot wire in a heat lamp gives off waves of radiant energy called *infrared rays.* When these rays strike someone, their energy warms that person.

When heat passes into or out of a substance, it may change that substance in three ways. Heat may cause (1) changes in temperature, (2) changes in size, and (3) changes in state.

Changes in temperature are one of the most common results when heat flows into or out of an object. The amount of heat needed to raise the temperature of one gram of a substance one degree Celsius is called the *specific heat capacity* of the substance. Specific heat capacity is often called simply *specific heat.* Scientists use the specific heat of water, which is given a value of 1, as the standard for calculating the specific heat of all other substances.

You can find out how much the temperature of a substance will rise when heat flows into it if you know how much *mass* (amount of matter) the substance has and what the specific heat of the substance is. First, multiply the mass by the specific heat of the substance. Then, divide the result into the amount of heat added. For example, if 10 calories of heat flow into one gram of water, how much will the temperature of the water rise? One gram multiplied by a specific heat of 1 equals 1. One divided into 10 calories equals a rise of 10 degrees Celsius.

Two substances with the same mass but different specific heats require different amounts of heat to reach the same temperature. The temperature of a substance with a low specific heat will increase more than that of a substance with a high specific heat if both substances receive the same amount of heat. For example, it takes 10 calories of heat to raise one gram of water 10 degrees Celsius. But 10 calories will raise the temperature of one gram of copper 111 degrees. Copper has a low specific heat of 0.09, compared with water's specific heat of 1.

Changes in size. As we have seen, when heat flows into a substance, the motion of the atoms or molecules in the substance increases. As a result of their increased motion, the atoms or molecules take up more space and the substance expands. The opposite occurs when heat flows out of a substance. The atoms or molecules move more slowly. They therefore take up less space, and the substance contracts.

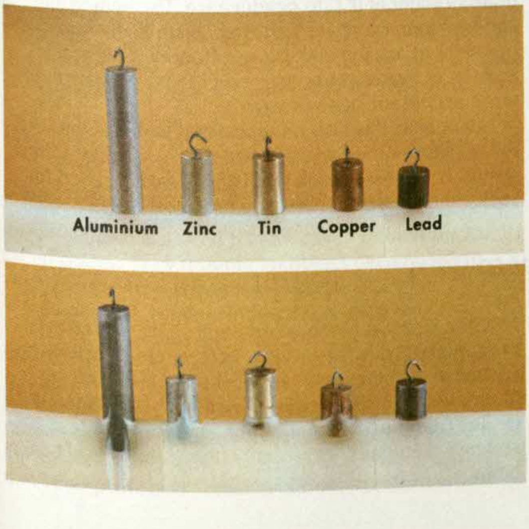
All gases and most liquids and solids expand when heated. But they do not expand equally. If a gas, a liquid, and a solid receive enough heat to raise their temperatures the same amount, the gas will expand most, the liquid much less, and the solid the least.

Thermometers, thermostats, and many other devices work on the principle of expansion and contraction. Many thermometers contain a liquid, such as alcohol or mercury, that expands and contracts evenly as the temperature changes. A rise or fall in temperature causes the volume of the liquid to expand or contract only slightly. But by making the liquid occupy a narrow glass tube, the liquid column moves enough so the temperature change can be seen.

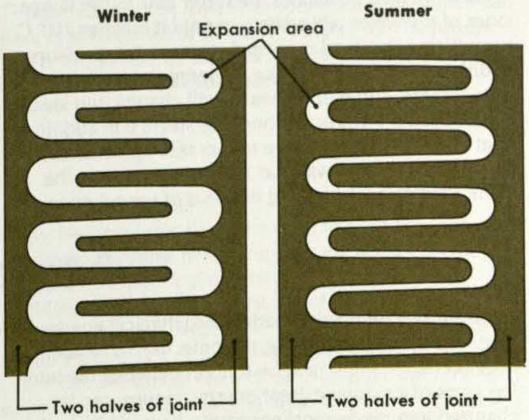
Changes in temperature also cause the materials that are used in bridges, buildings, and other structures to expand and contract. This expansion and contraction can cause serious problems if the builders do not allow for it. For example, the steel beams used in a building will bend or break if they do not have room to expand. For this reason, structures have *expansion joints,* which allow extra space for the materials to expand and contract without damage when the temperature changes.

Engineers can determine how much the length of any material will increase when its temperature rises if they know the *coefficient of linear expansion* of the material. The coefficient of linear expansion indicates how much longer each metre of the material will become if its temperature increases by one degree. For aluminium, it is 0.000023. Thus, each metre of an aluminium bar becomes 0.000023 of a metre longer with each degree Celsius increase in its temperature.

The specific heats of different metals can be compared by heating samples of equal weight to the same temperature and then setting them on a block of wax, *top.* The samples with high specific heats sink deepest in the wax, *bottom.*

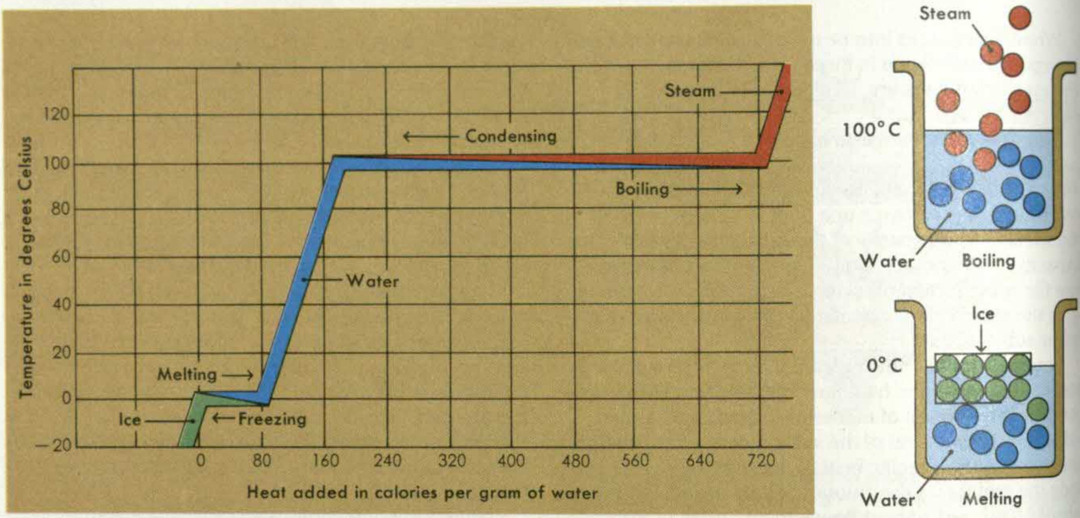


An expansion joint allows the materials in bridges, buildings, and other structures to contract and expand without damaging the structure. The joint opens in cold weather, when the materials contract, and closes in warm weather, when they expand.



In cold weather, the fingers of the joint pull apart as the materials contract.

In warm weather, the fingers move closer together as the materials expand.



Heat causes solids to melt and liquids to boil. The heat added to a solid, such as ice, raises its temperature to its melting point. Then the temperature stops rising until enough additional heat flows in and melts all the ice. More heat raises the temperature of the water to the boiling point. The temperature again stops rising until enough heat is added to turn all the water to steam.

Changes in state. Ordinarily, the temperature of an object rises when heat flows into it. But under certain circumstances, the addition of heat causes no increase in an object's temperature. Instead, the disorder of the atoms or molecules in the object increases and causes the material to change state.

If heat is added to a block of ice that is colder than 0° C, the temperature of the ice will increase until it reaches 0° C, its melting point. Then the temperature will stop increasing for a time, even though more heat flows into the ice. The additional heat will increase the disorder of the molecules in the ice and cause the ice to melt. But until all the ice has melted, the water will remain at 0° C. The heat needed to change ice to water is called the *heat of fusion.* Each gram of ice at 0° C requires 80 calories of heat to melt it to water at 0° C.

As more heat flows into the water at 0° C, the temperature of the water will again rise until it reaches 100° C, its boiling point. Under normal atmospheric pressure, additional heat will not raise the temperature any further. Instead, some of the water will change into steam. Not until all the water has become steam will additional heat cause the temperature to increase again. The heat required to change water at 100° C into steam at the same temperature is called the *heat of vaporization.* Each gram of water at 100° C requires 540 calories of heat to become steam. More heat added to the steam will raise its temperature above 100° C.

A liquid can also become a gas at a temperature below its boiling point through evaporation. Evaporation occurs at the surface of a liquid. The molecules at the surface break free from those below and enter the air as a gas. The speed at which evaporation occurs depends on the kind of liquid, the temperature of the liquid, and the amount of liquid vapour above the liquid.

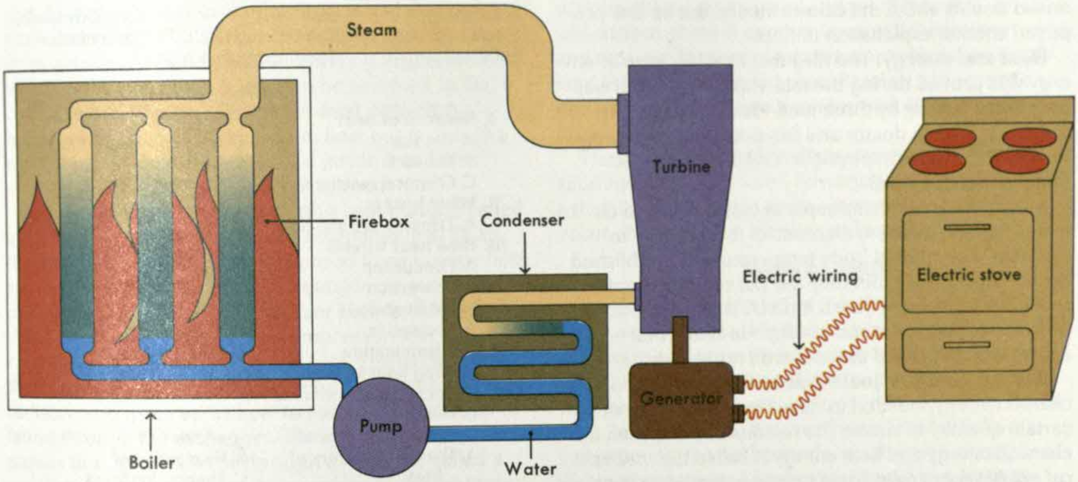
The heat needed to change a material from a solid to a liquid or from a liquid to a gas is called *latent heat.* It must be removed to change a gas back to a liquid or a liquid back to a solid. That is, 540 calories of heat must be removed from each gram of steam at 100° C to produce water, and 80 calories must be removed from each gram of water at 0° C to produce ice. The boiling and condensation points of a substance are at the same temperature, as are the melting and freezing points. The amount of heat that has entered or left a substance determines the substance's state.

Latent heat may also be associated with changes in the structure of the crystals that make up a solid substance. In general, much less latent heat is needed for such changes than for melting or vaporization.

Putting heat to work

Changing heat into motion. Mechanical energy and heat energy are related. For example, mechanical energy is changed into heat by friction between the moving parts of a machine. Heat energy, in turn, can be changed into mechanical energy by *heat engines.*

Heat engines can be divided into two groups: (1) *external-combustion engines* and (2) *internal-combustion engines.* External-combustion engines use heat that is produced outside the engine. Such engines include gas and steam turbines and reciprocating steam engines. Internal-combustion engines produce heat inside the engine from burning fuels. Such engines include diesel and petrol engines, jet aircraft engines, and rocket engines.



Heat energy can be changed into other forms of energy. This diagram shows how heat is changed into electricity. Heat in a boiler creates steam that turns a turbine. The turbine drives an electric generator. A condenser changes the steam back to water, and the cycle is repeated.

A steam turbine is a good example of an external-combustion engine. Heat from burning fuel or from a nuclear reactor changes water in a boiler to steam. Pipes carry the steam into the turbine, which has a series of bladed wheels attached to a shaft. The high-temperature steam expands as it rushes through the turbine and so pushes on the blades and causes them to turn the shaft. Steam leaving the turbine has a much lower temperature. The spinning shaft can drive an electric generator, move a ship's propeller, or do other useful work. See **Turbine** (Steam turbines).

A car petrol engine is a good example of an internal-combustion engine. The burning of petrol in the cylinders of the engine produces hot gases. The gases expand and push down the pistons in the cylinders. The motion of the pistons moves other parts of the car that turn the car's wheels. See **Petrol engine.**

Refrigeration. The temperature of an object can be lowered by bringing it in contact with a colder object. The temperature difference causes heat to flow from the warmer object into the colder one. For example, ice put in an insulated chest keeps food cold by removing heat from it. Another way to remove heat from an object without using a colder object is *mechanical refrigeration.*

Mechanical refrigeration works by changing a substance called a *refrigerant* from a gas to a liquid and back to a gas again. In a refrigerator, for example, a compressor squeezes a gaseous refrigerant into a small space. The compression reduces the refrigerant's disorder so much that it becomes a liquid. The compressed liquid refrigerant then expands at a valve leading to pipes in the insulated part of the refrigerator. As the pressure falls, so does the temperature, and the refrigerant absorbs heat from the foods in the refrigerator. As heat flows out of the foods, their temperature falls. The warmed refrigerant becomes a gas and then flows through pipes back to the compressor. There, the refrigeration cycle begins again. See **Refrigeration** (Mechanical refrigeration).

Theoretically, the lowest temperature a substance can have is *absolute zero,* which is −273.15° C. The production of temperatures close to absolute zero is the field of cryogenics. See **Cryogenics.**

Learning about heat

The caloric theory of heat. Until the late 1700's, many scientists believed that heat was an invisible fluid called *caloric.* They thought an object became warm when caloric flowed into it and grew cold when caloric flowed out of it. Because objects weighed the same whether they were hot or cold, the scientists reasoned that caloric had no weight and therefore could not be matter.

Near the end of the 1700's, the work of two men raised questions about heat that the caloric theory could not answer. In 1798, the American-born scientist Benjamin Thompson, also known as Count Rumford, observed the manufacture of cannons in Munich, Germany. He noted that the drills used to bore the cannons produced frictional heat even after the drills became dull and no longer cut out metal. The caloric theory could not account for the release of heat unless a drill actually cut metal. Yet an unlimited quantity of heat resulted as long as a drill turned against metal.

In 1799, the British chemist Sir Humphry Davy melted two pieces of ice by rubbing them together in a container at a temperature below the freezing point of water. Again, the caloric theory could not account for the heat produced. Thompson's and Davy's observations raised doubts about the caloric theory. But no one proposed another explanation of heat.

Heat and energy. The idea that heat is a form of energy was proved during the mid-1800's. The proof was developed largely by three men—Julius Robert von Mayer, a German doctor and physicist; Hermann von Helmholtz, a German physicist; and James Prescott Joule, a British physicist.

Mayer observed that people in warm and cold climates needed different amounts of food energy to maintain their normal body temperature. He published his findings in 1842, but they did not receive scientific recognition for many years. In 1847, Helmholtz published a work on heat and energy. He stated that heat is a form of energy, and the idea won rapid acceptance.

During the 1840's, Joule measured the amount of mechanical energy needed to raise the temperature of a certain quantity of water. The relationship between mechanical energy and heat energy is called the *mechanical equivalent of heat.* Joule's early experiments showed that 4507 joules of mechanical energy produced 1 calorie of heat. Later scientists made more precise measurements. They found that the mechanical equivalent of heat was 4.184 joules per calorie. The joule was named after James Prescott Joule.

Thermodynamics is the study of the relationship between heat and other forms of energy. It is based on three *laws* (principles).

The first law of thermodynamics is the law of conservation of energy. It states that energy is never created or destroyed. Energy may change form—for example, from internal energy to mechanical motion—but the total quantity of energy in any *system* (group of things) remains the same.

According to the second law, all *spontaneous* (natural) events act to increase the entropy within a system. Until a system reaches its maximum entropy, it can do useful work. But as a system does work, its entropy increases until the system can no longer perform work.

The third law of thermodynamics concerns absolute zero. It states that it is impossible to reduce the temperature of any system to absolute zero.

Study aids

Related articles in ***World Book*** include:

Biographies

Clausius, Rudolf J. E.
Davy, Sir Humphry
Gibbs, Josiah W.
Helmholtz, Hermann L. F. von
Joule, James P.
Kelvin, Lord
Mayer, Julius R. von

Other related articles

Absolute zero
Boiling point
British thermal unit
Calorie
Celsius scale
Coal
Combustion
Cryogenics
Electricity
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Entropy
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Fuel
Gas (fuel)
Heating
Infrared rays
Insulation
Metabolism
Molecule
Nuclear energy
Nuclear weapon
Perpetual motion machine
Petroleum
Solar energy
Steam
Sublimation
Sun
Temperature
Thermocouple
Thermodynamics
Thermometer

Outline

- **I. Sources of heat**
  - A. The sun
  - B. The earth
  - C. Chemical reactions
  - D. Nuclear energy
  - E. Friction
  - F. Electricity
- **II. What heat is**
  - A. Temperature and heat
  - B. Disorder
- **III. How heat travels**
  - A. Conduction
  - B. Convection
  - C. Radiation
  - D. Insulation
- **IV. What heat does**
  - A. Changes in temperature
  - B. Changes in size
  - C. Changes in state
- **V. Putting heat to work**
  - A. Changing heat into motion
  - B. Refrigeration
- **VI. Learning about heat**
  - A. The caloric theory of heat
  - B. Heat and energy
  - C. Thermodynamics

Questions

What was the *caloric* theory of heat?
Why do bridges and buildings have *expansion joints*?
In what three ways does heat travel?
What is our most important source of heat?
What is specific heat?
What is the basic difference between temperature and heat?
How does insulation stop heat from travelling by convection?
What do *heat engines* do?
In what ways may the addition or removal of heat change a substance?

Heat exhaustion. See **Sunstroke; First aid** (Heatstroke and heat exhaustion).

Heat pipe is a device that transfers large amounts of heat from one place to another at a fairly constant temperature. Heat pipes can transport much more heat per unit area than the best metal conductors, including copper and silver. Unlike most heat transfer devices, they require no external power source. This feature makes them more energy-efficient and more economical.

Heat pipes are used to remove waste heat from certain types of electronic equipment and machinery. In many cases, they carry this heat to another place where it can be used. Some air-conditioning and heating systems employ heat pipes to regulate temperature.

A heat pipe consists of a metal tube that is sealed at both ends and lined with a porous material. The lining, called the *wick,* holds a liquid, such as water, methanol, or molten lithium. This liquid is known as the *working fluid.* It absorbs heat from a heat source at one end of the tube and vaporizes. The vapour flows out of the wick and builds up pressure at the hot end of the tube. This pressure causes some of the vapour to travel to the cooler end of the tube. There the vapour condenses as it cools, transferring its heat through the tube wall. The liquid returns to the warmer end of the tube through the wick as a result of *capillarity* (see **Capillarity**).

The temperature of the heat delivered by a heat pipe is roughly equal to the working fluid's *boiling point,* the temperature at which the liquid vaporizes. The boiling point remains constant as long as the atmospheric pressure does not change. For this reason, heat pipes provide precise temperature control.

Heat pump is a device that takes heat from one area and delivers the heat to another area at a higher temperature. In heating a building, a heat pump absorbs heat from outside the building and delivers it inside. In warm weather, the same heat pump can be reversed so that it cools the building and discharges heat outside. A household refrigerator is a type of heat pump. A refrigerator absorbs heat from the food inside it and discharges the heat to the surrounding room air.

The fluid that circulates through a heat pump is called a *refrigerant.* For heating, a cold refrigerant first flows through coils of pipe that are exposed to an outside heat source. The heat source may be outside air, well water, or even the ground. The refrigerant absorbs heat from these sources, then goes to a compressor which increases its temperature and pressure. The refrigerant then flows to a heat exchanger, which resembles a car radiator, and gives up its heat to room air which is circulating through the exchanger. The refrigerant then passes through a valve or through a restrictor called a *capillary tube.* This lowers the pressure of the refrigerant, resulting in a drop in temperature. The cycle is repeated as the refrigerant circulates again through the coils of pipe and picks up heat from the heat source.

For cooling purposes, valves reverse the direction of the refrigerant flow. The refrigerant vapour flows from a compressor at high temperature and pressure through the outside coils. At this point, water, earth, or outside air absorbs heat from the hotter refrigerant. This takes place even if the outside source is warm, because it is cooler than the refrigerant. The refrigerant then passes through a valve that lowers its pressure, thus decreasing the temperature. In the heat exchanger, the refrigerant absorbs heat from the room air. The refrigerant then returns to a compressor and the cycle is repeated. Heat pumps are controlled by thermostats that sense the temperature of the room and turn the compressor on and off.

See also **Air conditioning; Heating** (diagram: Heat pump); **Refrigeration.**

Heat rash. See **Prickly heat.**

Heat shield is a covering on a spacecraft or a rocket nose cone. It protects astronauts and instruments from the intense heat produced during high-speed flights through the atmosphere. Such heating occurs when a spacecraft descends from an earth orbit. Atoms and molecules of air generate heat by friction against the surface of the craft. The greater the craft's velocity, the more intense the heat. Common types of heat shields are heat sinks and ablation shields. *Heat sinks* absorb great amounts of heat, thus preventing heat from reaching delicate parts of the spacecraft. *Ablation shields* use up heat by melting and vaporizing. The air stream carries the molten particles and hot gas vapour away from the craft. Commonly used heat shield materials include graphite, graphite composites, and porous ceramics.

Heath is the name given to a habitat where the main plants are shrubs belonging to the heather family. Heathland shrubs grow to between 30 centimetres and one metre in height. In a mature heath, this shrub cover is difficult to walk through. Common heathland shrubs are broom, heather or ling, and species of gorse. Below the taller shrubs there is normally a second layer, 10 to 20 centimetres high, formed by plants such as the bearberry, bell heather, cowberry, and crowberry, mixed with heathland grasses and sedges. Below that, on the soil surface, there is another layer of lichens, liverworts, and mosses. Another plant commonly found on heathland is the large fern, bracken. Bracken can spread rapidly into areas that have been burned, because of its fast-growing underground stems.

The colours of heathland are generally muted and subdued. In late summer, flowering heather gives heath a purple sheen, and in areas where gorse or broom occur, there are also swathes of bright yellow.

Types of heath

Heath generally develops over light, sandy soil that drains easily. It is mostly found in northern and western Europe, in regions with moderate temperatures and high rainfall (40 to 100 centimetres per year). Countries with large areas of heath include Ireland, Britain, northwest Portugal and Spain, northwest France, Belgium, Luxembourg, the Netherlands, northwest Germany, Denmark, southern Sweden and southwest Norway. These Atlantic heaths are a semi-natural community and are a result of interference by people and grazing animals. They would naturally be covered by deciduous woodland.

On heaths, the high rainfall washes directly down through the soil, taking with it many of the nutrients out of the top layers. Such heathland soils, known as *podsols,* are very poor and sandy, and only species such as heather thrive in them. These soils make it difficult for trees and woodland herbs to grow, because the soil is not rich enough.

Another kind of heath is found in mountains, above the tree-line, but below the open tundra-like communities of the cold mountain tops. Here, conditions are too exposed for tree growth, so that woody shrubs, many related to heather, dominate. In the Alps, for example, heaths occur at a height of between about 1,500 and 2,500 metres. These are often dominated by the alpenrose, crowberry, or trailing azalea. These mountain heaths tend to be lower-growing than the Atlantic heaths.

In northern Europe, the main shrubs of heathland

Northern heaths are dominated by heather plants with gorse bushes, patches of acid grassland and scattered conifer trees.

found with heather include bilberry, cowberry, and crowberry. In wetter places, cross-leaved heath is common, and this may be found together with bog species such as cotton grasses and rushes. In western oceanic heath, species of gorse such as common gorse, dwarf gorse, and western gorse are typical. In drier inland areas, broom and petty whin can be found. In southern Europe, Mediterranean species such as the tree heath are found, and there are areas of drier scrubland, known as *maquis*.

Animals of Atlantic heaths include many butterflies, such as the small heath, and grayling. Both species feed upon heathland grasses. Several species of grasshopper are also common.

Heathland conditions also suit reptiles particularly well. Reptiles are cold-blooded animals that need to warm up quickly before they can move about. The sandy soils of heaths heat up very fast when the sun shines, making them the ideal habitat for reptiles. The smooth snake and sand lizard are both heathland specialists, and the common lizard and the poisonous adder also thrive on heaths. Heathland birds include the Dartford warbler, nightjar, red-backed shrike, and stone curlew.

European heaths, especially the drier southern heaths, are under increasing threat and are disappearing fast. Increasingly, heaths are built on, or ploughed up for agriculture. They are in need of urgent protection, for the unique wildlife they support may die out.

There are also habitats called heath in the Southern Hemisphere, including Australia. They look a bit like Atlantic heaths in structure, but they are found in a much drier climate. Australian heath covers large areas in southwestern and south Australia, in regions with about 45 centimetres rainfall a year, and with 7 months of summer drought. Like European heath, Australian heath is maintained by fire and grazing. However, much of it may be natural and have originated in areas where natural fires were started by lightning. Here, the heather family shrubs are replaced by members of the family Proteaceae, such as banksia. Other shrubs include grass tree or blackboy, and shrubby eucalypts. See **Banksia; Protea.**

As well as referring to the heathland habitat, the name heath is also used for many heathland shrubs, belonging to the same family as heather. See **Heather.**

Heath, Sir Edward (1916-   ), was prime minister of Great Britain from 1970 to 1974. Under his leadership, the Conservative government led Britain into the European Economic Community, now the European Union (see **European Union**). But it suffered from a poor record in labour relations and rising violence in Northern Ireland. Heath called parliamentary elections in 1974, but his party narrowly lost its majority. Heath resigned, and was succeeded by the Labour Party leader, Harold Wilson. He was knighted in 1992.

The Conservatives were defeated in further elections in 1974 and, in 1975, Heath was replaced as party leader by Margaret Thatcher.

Heath had been one of the few Conservative leaders who did not inherit wealth and privilege. Edward Richard George Heath was born in Broadstairs, Kent, the son of a carpenter, and attended the state-run Chatham House School where he won a scholarship to Balliol College, Oxford. At university, Heath became active in Conservative Party politics and, in 1939, he was elected president of the Oxford Union, one of Britain's leading debating societies.

Edward Heath

During World War II, Heath served as a gunner in the Royal Artillery. He saw action in France, Belgium, Holland, and Germany, reaching the rank of major. He served in the post-war Territorial Army as a lieutenant colonel, while working in the Civil Service.

Heath entered the House of Commons in 1950 as the Conservative member for Bexley, Kent. He held the seat until boundary changes in 1974, when he took over the nearby seat of Sidcup. Heath advanced quickly under the Conservative government of 1951-55. He held a series of administrative posts and, in 1955, became chief whip, responsible for party voting. In 1959, he entered the cabinet as minister of labour.

Between 1960 and 1963, Heath was chief negotiator in Britain's unsuccessful effort to join the European Economic Community. In 1963, he was appointed secretary of state for industry but the Conservative Party lost office the following year.

In 1965, Heath became the first Conservative leader to be elected by balloting of the entire parliamentary party. This was followed by defeat at national elections in 1966. But, with economic inflation and public disorder both mounting, Heath became prime minister after the Conservative victory in the 1970 elections.

In 1971, Heath's government carried through the controversial policy of interning suspected members of the Irish Republican Army in Northern Ireland. The entry into the European Economic Community in 1973 was supported by only a small majority of the electorate.

Heath's government established an Industrial Relations Court with the power to imprison trade unionists who led illegal strikes. During a national strike by coal miners in the winter of 1973, Heath placed industry on a three-day working week. Early in 1974, he called for parliamentary elections but the Conservative Party narrowly lost its majority.

When the Conservatives regained power in 1979, under the new prime minister, Margaret Thatcher, Heath remained in the House of Commons but did not rejoin the cabinet. He campaigned for greater integration in Europe and for policies to reduce unemployment. His published works include *One Nation* (1950), and books on sailing, music and travel.

Heath hen. See **Prairie chicken.**

Heath Robinson, William. See **Robinson, William Heath.**

Heather is a common shrub of heathland areas. It is native to Europe but also grows in North America, where it has been introduced. Heather is also known as *ling*, or *Scottish heather*.

Heather has small, rough leaves and purple or white flowers. The flowers are attractive to bees and honey made from heather has a distinctive flavour. Heather is

Bell heather grows on dry heaths and moors. It has deep green leaves and flowers that may be deep pink, red, maroon or white.

most widespread in the heaths of western and northern Europe, where it grows on sandy or peaty soils. Some upland areas, especially in the British Isles, are managed as moors for rearing red grouse. The name heath is also used for many European and African shrubs belonging to the heather family. There are about 665 species of heath, about 600 of which grow wild in southern Africa. They are common in heathland, in Mediterranean *maquis* (scrub) and especially in the *fynbos* (scrub) of the Cape Region of South Africa. Heaths have small, bell-shaped flowers which hang down, and are clustered around the stem. The flowers are red, pink, purple, yellow or white and attract large numbers of visiting insects. *Bell heather* belongs to the same family as the true heather but it is more closely related to the heaths. Other heaths include *cross-leaved heath, tree heath* (or tree heather) and *Dorset heath.*

Heaths vary in height from a few centimetres to several metres. The tree heath is one of the larger species. It grows to the size of a small tree and is found in the Mediterranean area and also in the mountains of tropical Africa. The knobbly wood from the tree heath is traditionally used to make briar pipes.

Plants called heaths are also found in Australia and New Zealand. These belong to a different family. Examples are *spindle heath,* which is found in swampy habitats in Western Australia, and *globe heath* which has clusters of small red flowers and grows in southwest Australia.

Scientific classification: Heather and the European and African heaths belong to the family Ericaceae. Heather (or ling) is *Calluna vulgaris;* bell heather is *Erica cinerea;* cross-leaved heath is *Erica tetralix;* tree heath (or tree heather) is *Erica arborea;* Dorset heath is *Erica ciliaris;* Australian heaths belong to the family Epacridaceae. Spindle heath is in the genus *Cosmelia* and globe heath belongs to the genus *Brachyloma.*

Heating. The development of efficient indoor heating systems has made it possible for people to live and work in places far from the warm parts of the world. Without such heating systems, people must spend too much of their time and energy combating winter cold in the temperate and frigid zones of the earth.

The first heating systems were open fires in crude caves. When human beings discovered a way to dig a hole in the side or top of a cave to let out the smoke, the first fireplace was developed. Later on, these fireplaces were provided with separate chimneys. After such fireplaces came stoves made of brick and tile, and then of cast iron. Finally, central heating systems were developed. These systems are used in many homes, office and industrial buildings, and schools today. Special heating systems for cars, trains, ships, and aeroplanes enable people to travel comfortably in cold weather.

Principles of heating

Comfort. Human beings are warm-blooded animals. Their bodies have the relatively high average temperature of 37° C. Food provides fuel for this body heat. When the temperature surrounding the body is extremely cold, the body loses too much heat. Clothing reduces the loss of heat. But for comfort in cold regions, indoor heating must be provided.

Most people feel comfortable in a room with a temperature of from 21° to 26° C. The humidity in a room also affects comfort. If two rooms have the same temperature but different humidity, most people will feel warmer in the room with the higher humidity. An indoor *relative humidity* of from 30 per cent to 60 per cent is the most comfortable for most people (see **Humidity**). The temperature in a home can be lower without sacrificing comfort for some people if moisture is added to the air with a device called a *humidifier.* However, adding the moisture may require more energy than simply raising the temperature.

Heat transfer. Heat is transferred in three important ways: *conduction, convection,* and *radiation.* Conduction is the heating of matter by bringing it in contact with a hot object. The heat passes directly from the hot object to the adjacent matter.

In natural convection, the hot object heats the surrounding air. This heated air rises because of its lighter weight. The hot air, in turn, is replaced by cool air which, in turn, is heated and rises. In this way, a continuous current of warm air rises from near a hot object, just as hot air rises over a bonfire or a hot stove.

A hot object radiates heat in the form of waves much like radio and light waves. These waves can go through a vacuum or through dry air without heating it. The earth receives radiant heat from the sun.

Central heating systems

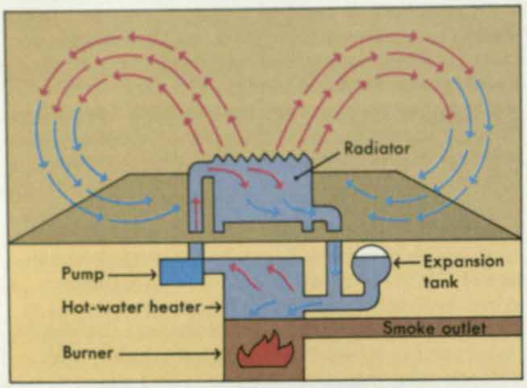
Central heating systems generate heat for an entire building at one central place. The heat is then delivered where it is needed. Most systems serve only one building. But some heat a group of buildings, such as those at a school, a college, or a block ot flats.

Central heating systems have automatic controls, with a thermostat to regulate the temperature of the rooms heated by the system. The thermostat turns on the system when the temperature drops below the setting of the thermostat. Most thermostats include a device called an *anticipator* to help the thermostat keep the room at an even temperature.

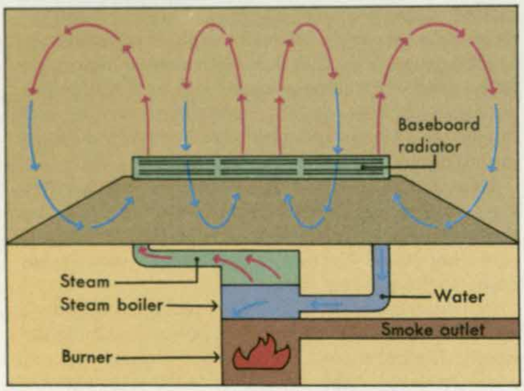
Another automatic control turns off the central heating system if any part of it becomes dangerously overheated. Still another control prevents the system from starting unless it can start safely.

There are two main kinds of central heating systems:

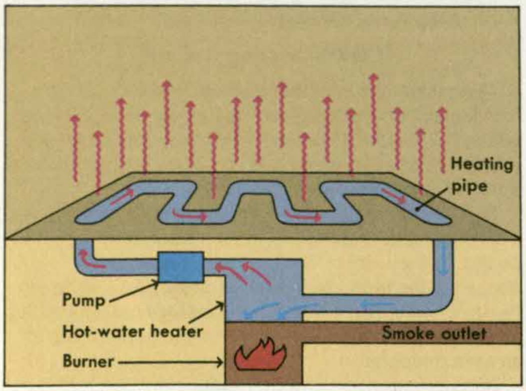
Basic heating systems



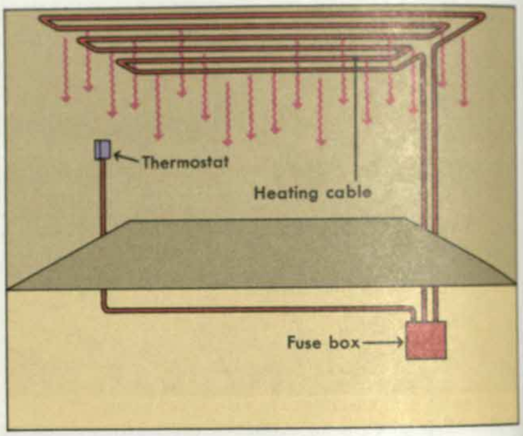
Hot-water heating. Fuel is burned in a hot-water heater to heat water. A pump forces the hot water through pipes to a radiator in each room being heated. The water gives up its heat to the room and returns to the boiler through another pipe.



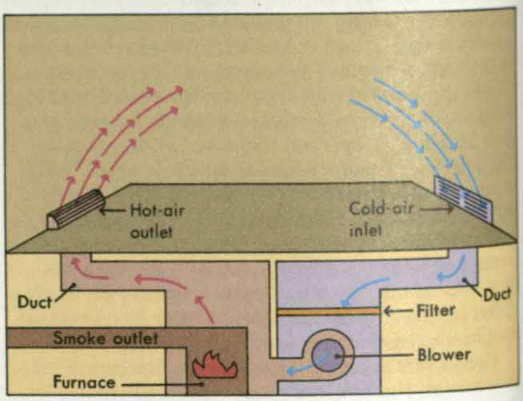
Steam heating works much like hot-water heating, except that water changes to steam in a boiler. The steam passes through pipes to convectors, where it gives up its heat to the room and becomes liquid again. The water then flows back to the boiler.



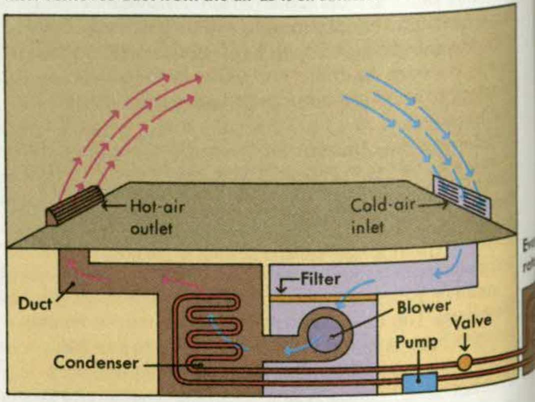
Radiant hot-water heating. Water is heated in a boiler and pumped through a continuous coil of pipe in the floor of the room being heated. Heat radiates from these pipes and keeps the room temperature nearly the same from floor to ceiling.



Radiant electric heating uses a cable that produces heat from electricity. The cable radiates heat to the room and may be installed in the ceiling or floor or along the skirting board. A thermostat controls the amount of heat produced by the cable.



Warm-air heating. A furnace heats the air, and a blower forces it through a duct to an outlet that opens into the room being heated. Cool air returns to the furnace through another duct. A filter removes dust from the air as it circulates.



Heat pump. A heating system that uses a heat pump operates much like a warm-air system. But the heat pump uses a condenser, evaporator, pump, and other equipment to get heat from outside air or the ground and "pump" it into the building.

(1) direct and (2) indirect. They differ in the way they distribute heat. A direct system circulates the warm air throughout the area being heated. An indirect system circulates steam or hot water through pipes to *convectors* or *radiators*, which give off heat.

Warm-air heating. A warm-air heating system warms the air in a furnace and then forces it through a system of *ducts* (pipes) to each room. Another system of ducts carries cool air from the rooms back to the furnace. An electrically driven blower in the furnace moves the air through the ducts, and filters remove dust particles from the air.

Some private homes have warm-air systems. These systems can do more than just heat the air. With a humidifier, for example, a forced warm-air system adds moisture to the air and increases the humidity throughout the home. The ducts and blower can be used as part of a central air-conditioning unit.

Steam and hot-water heating systems. Steam or hot-water heating systems are used in many large buildings. These systems cost more than warm-air systems, but they have certain advantages over them. The pipes carrying steam or hot water are smaller than warm-air ducts and thus take up less space. Automatic valves can control the amount of hot water or steam flowing to convectors more easily than they can control warm air. Thus, it is easier to control the temperature in different rooms with these systems than with warm-air heating.

A steam heating system requires a boiler, and a hot-water heating system has a hot-water heater, also called a boiler. Fuel burning in the boiler produces heat for the system. The system also has a network of pipes and convectors. In steam heating, a condensate pump forces the condensed steam back to the boiler. In hot-water heating, a pump circulates the water through the system.

The convectors of a steam or hot-water system, often called radiators, give off most of their heat by convection and radiation. The amount of heat given off by radiation depends on the temperature of the convector and its surface area. With lower temperatures typical of hot-water heating, a greater part of the heat is delivered by convection and less by radiation. The amount of heat given off by a convector depends upon its shape and the amount of exposed metal surface. The more metal that is exposed, the more heat is given off.

One difficulty in heating with high temperature convectors is that the air near the ceiling becomes warmer than the air in other parts of the room. For example, the air at knee height may be 16° C, the air at breathing level may be 20° C, and the air at the ceiling may be 24° C. The air at floor level may be only 12° C. Such a low floor temperature is too cold for comfort. If an attempt is made to raise the temperature of the floor, the average room temperature increases and the upper parts of the room become uncomfortably warm.

Radiant heating is a method of equalizing temperature within a room. A continuous loop of hot-water pipe or electric cable is installed in the ceiling or floor. Heat leaves the pipe or cable by radiation, which does not directly raise the temperature of the air within a room. Radiation affects only the objects it strikes, and so it produces more uniform heating than convection does. Radiant heat provides comfort at a lower room temperature than other heating systems.

Radiant heating may also be installed along the skirting boards of a room. One system uses a metal shield about 15 centimetres high to cover a hot-water pipe that runs close to the floor. Such a system distributes heat evenly. All radiant heating systems limit the temperature difference between the floor and the ceiling to only a few degrees.

Electric heating differs from other central systems because it requires no combustion of fuel in the building being heated. The fuel used to make electricity is burned at an electric power plant that may be far away. Nuclear plants produce electricity from nuclear energy.

Electric heat is produced by electric heating units. Such units produce heat by passing electricity through a material that resists the flow of current. This type of heating, called *resistance heating*, produces much radiant heat. Such heat warms the surface of the skin and clothing and makes people feel comfortable even in a cool room. An electric heating unit can be placed in the ceiling, skirting boards, floor, or wall. The temperature can be controlled by thermostats in each room, or area.

Heat pumps. Even in cold weather, the earth or outside air contains heat that can be used to heat a building. A mechanical system called a heat pump takes heat from the outside air and brings it inside. In cold weather, a heat pump circulates a liquid refrigerant through a coil outside the building. As the cold liquid passes through the coil, it picks up heat from the outside air or earth and becomes a vapour. The vapour then passes into a compressor. The compressor increases the temperature and pressure of the vapour. Then the hot vapour passes through an inside coil, where it heats the air. In the process, the vapour condenses into a hot liquid. The hot liquid then goes through a pressure-reducing valve and becomes cold again. Finally, the refrigerant is forced back to the outside coil and the cycle begins again.

In cold regions, a heat pump may not be able to supply all the necessary heat economically. In such places, electric resistance heating units provide additional heat on the coldest days. In warmer weather, a heat pump reverses its operation. It cools the building by pumping heat from the inside to the outside.

Sources of heat

Most people heat their homes with electricity, gas, or oil. At one time, many private homes were heated with coal. But gas, oil, and other fuels have become more popular in homes because they are more convenient and produce less pollution.

In the 1970's, many countries faced shortages of petroleum fuels and some other energy sources. People termed this situation an "energy crisis." To conserve energy, scientists and engineers stepped up their efforts to develop more efficient heating systems and better insulation. They also attempted to develop efficient ways to harness energy from the sun.

Electricity provides convenient, comfortable heating. Resistance electric heating offers such major advantages as cleanliness, safety, and low maintenance expense. But it usually costs more than other heating methods. To help reduce costs, manufacturers of electric heating units have designed *electric storage heaters*. Such heaters use electricity to generate large amounts of heat during the late-night hours when rates are generally lower. These units store the heat until daytime, when it can be used to maintain comfortable room temperatures without the use of additional electricity.

Electric heat is clean for the homeowner. But the power plants that generate the electricity must burn about three units of energy for every one unit that is delivered to the home. In addition, the increased use of electricity for heating and other uses requires the construction of more power plants.

Many engineers believe it is more efficient for homes to burn fuel for heat than to produce electricity for heating. These experts point out that the best power plants change only about 30 to 40 per cent of the energy they use into electricity. A gas or oil heating system can deliver more than 60 per cent of the energy it consumes as heat. A heat pump driven by gas or oil can collect enough additional heat energy from external sources so that it delivers 1½ times the energy it uses.

Gas produces heat with little air pollution. Nearly all the gas used for heating homes in many parts of the world is natural gas. Natural gas comes from underground rock formations, as does oil. Most natural gas reaches homes through pipelines. Gas is simple to burn. A gas furnace pipes the fuel to burners that ignite it.

Oil. Fuel oil used for home heating comes from the refining of petroleum. Local trucks deliver the oil to homes, where it is stored in tanks until used. A home oil furnace has either a *pot type* or a *gun type* burner. In a pot type burner, the fuel oil flows into a shallow depression in the bottom of the furnace. In a gun type burner, the oil is sprayed through a nozzle under air pressure. The burner uses an air pump to vaporize the fuel. The added air makes the oil burn more efficiently.

Coal for heating is available in several grades, depending on its heating capability and sulphur content. The two most common types of coal are *anthracite* (hard coal) and *bituminous* (soft coal). Anthracite produces less smoke and sulphur dioxide when burned than does bituminous coal. As a result, anthracite causes less pollution. However, butuminous coal is generally cheaper.

Other sources. In Iceland, geothermal energy is used to heat homes, offices, factories, sports facilities and greenhouses. This energy comes from deep within the earth, where the rocks retain much heat from the time when the earth formed. This heat is exploited in two ways. In areas where the rocks just below the surface are very hot, underground water is turned to steam. This steam may be pumped directly into homes for heating, or may be sent to power stations and used to generate electricity. In other areas, underground water is still hot enough to be pumped into homes for heating. Countries, such as Australia, with a lot of sunshine, can use solar panels to heat water during the day. The hot water can be used to warm the home during the night. See also **Solar energy** (Capturing direct solar energy).

Local heating systems

Local heating is in common use in many countries. Such heating comes from fireplaces, or room heaters.

Fireplaces. The earliest type of local heating system was the open fire within an enclosure, such as a cave or a tent. Such a fire is not satisfactory because the area soon becomes filled with smoke.

If a fireplace is put at one side of a room and provided with a chimney, the smoke and combustion gases will pass up the chimney. The chimney provides a draught by which the air enters the front of the fireplace and passes up the chimney to aid the burning of the fuel. However, this draught reduces the energy efficiency of a fireplace. A typical fireplace allows enough warm air to escape through the chimney to empty an average room every few minutes. This air leak may waste almost as much heat produced by the house's central heating system as is provided by a fireplace.

Room heaters. Some room heaters burn gas to produce heat. These can be placed in a corner of the room and used with a fan to circulate the heated air. Such heaters should not be used without adequate ventilation to the outside because combustion gases can be harmful to the occupants of the room. Other room heaters burn paraffin and must also be vented.

Electric room heaters pass an electric current through a series of wires. These wires resist the electricity and become red hot. Such electric heaters give off heat by radiation and convection.

Most local sources of heat are relatively hot, compared with steam and hot-water radiators. For this reason they produce a larger proportion of radiant heat. When such large amounts of radiant heat are used, the temperature of the air in the room need not become so hot. For example, a resistance-type electric heater called a *quartz heater* warms anyone in the path of its heat rays. But the heat rays do not significantly warm the air through which they travel.

Related articles in ***World Book*** include:

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Heat pipe
Heat pump
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Radiator
Solar energy
Thermostat

Heatstroke. See **Sunstroke.**

Heaven, in the teachings of many religions, is the place or spiritual state in which God, gods, or spirits abide. According to most of these religions, the souls of people who have been faithful to their religion and performed good deeds go to heaven as a reward. Many scriptures describe heaven as a place of dazzling beauty that fulfils every idea of perfection.

The major Western religions—Christianity, Islam, and Judaism—teach that heaven is eternal and dominated by the presence of God. Most Christians believe the supreme reward of heaven is the happiness of being close to God. For followers of Islam, heaven is a refreshing garden where the face of God is seen. Jewish scriptures refer to heaven as the upper part of the universe, but they mention few details. Many Jews believe a future *Messianic Kingdom* will establish a kind of heaven on the earth (see **Judaism** [The Messiah]).

According to two Eastern religions, Buddhism and Hinduism, heaven has many levels. These levels represent degrees of spiritual purity. Buddhists and Hindus believe that if they perform good deeds, their souls will ascend to such levels. But heaven is not eternal. The most advanced believers pass beyond heaven to the eternal states of nirvana or of buddhahood. The rest return and are reborn.

See also **Religion** (A doctrine of salvation); **Elysium; Nirvana; Paradise; Valhalla.**

Heaves, also known as *broken wind,* is a lung disease of horses. Horses suffering from heaves have difficulty exhaling and may develop a chronic cough. Their nostrils dilate and their sides heave as they struggle to breathe.

Heaves may result from any of a number of disorders that affect exhalation. The most common causes are allergies, prolonged inflammation of the lung airways by dust or mould, ballooning and rupturing of the tiny air sacs in the lungs, and viral or bacterial infections of the airways. Dietary factors also may be involved. Heaves may be mild and cause minor problems, or it may disable the horse completely. Important preventive measures include providing horses with clean, high-quality feed and well-ventilated shelters free of dust and mould. To relieve symptoms of heaves, veterinary surgeons prescribe rest, corticosteroids and other drugs, and control of the horse's feed and surroundings.

Heaviside, Oliver (1850-1925), an English mathematical physicist, suggested the existence of the upper atmosphere layer that reflects radio waves. This layer is now called the *Kennelly-Heaviside layer* (see **Ionosphere**). Heaviside also developed a mathematical theory of telegraphy. In 1873, he showed that four telegraph signals could be sent at the same time along a single wire.

Despite deafness, Heaviside continued his research. He solved the problem of interference in telegraph wires and studied electrons and electric charge. Heaviside was born in London and was self-educated.

Heavy hydrogen. See **Deuterium.**

Heavy water (chemical formula D_2O or ^2H_2O) is water that contains the heavy isotope of hydrogen called *deuterium* (chemical symbol D) in place of ordinary hydrogen. The deuterium atom has a mass about twice as great as an ordinary hydrogen atom. Heavy water is also called *deuterium oxide*.

Because of the difference between the masses of the two kinds of hydrogen atoms, the physical properties of heavy water differ from those of ordinary water. Heavy water freezes at 3.82° C, rather than at 0° C. It boils at 101.42° C, rather than at 100° C. Seeds will not germinate in it, and animals cannot live in it.

Heavy water is useful in some kinds of nuclear reactors called *heavy water reactors.* It acts as a *moderator,* to control the energy of the neutrons released in a chain reaction. It also acts as a *coolant,* removing the heat produced in the reactor core. This prevents the temperature in the core from becoming too high, and carries off the heat so it can be used to produce steam and power. Large amounts of heavy water are produced by a catalytic exchange of deuterium between water and hydrogen sulphide gas. The resulting deuterium-enriched water is then distilled.

Heavy water was first separated from ordinary water in 1932 by Gilbert N. Lewis, a chemist at the University of California, U.S.A.

See also **Deuterium** (Properties); **Nuclear energy** (Power reactors); **Nuclear weapon; Urey, Harold C.**

Hebe was a goddess in Greek mythology who served nectar to the gods and goddesses on Mount Olympus. She was the daughter of Zeus, the king of the gods, and of the goddess Hera. The name Hebe comes from a Greek word meaning *youth* or *prime of life.* The nectar Hebe served was believed to keep the gods and goddesses youthful. After the hero Heracles (Hercules in Latin) was made a god, Hebe became his wife. See also **Nectar; Hercules.**

Hebe is the name of about 75 species of evergreen flowering shrubs of the Southern Hemisphere. Most species come from New Zealand. Others are found in Australia and temperate South America. Hebes have tough leaves. Some species have overlapping, scale-like leaves like those of cypresses. Hebe flowers may be violet-blue, pink or white. Some cultivated types have red flowers. Hebes grow well in well-drained soil in a sunny position and do best in areas with frost free winters. They also require protection from strong winds.

Scientific classification Hebes belong to the family Scrophulariaceae, genus *Hebe.*

Hebrew Bible. See **Bible.**

Hebrew calendar. See **Calendar** (Hebrew).

Hebrew language and literature. Hebrew is one of the world's oldest living languages. The ancient Israelites who lived in Palestine during Biblical times spoke and wrote in Hebrew. The Bible itself is the greatest product of Hebrew literature. Today, Hebrew still serves as the language of Judaism, the religion of the Jews, and is also one of the official languages of Israel. Many Jewish authors also write in a language called Yiddish. For information about these writers, see **Yiddish language and literature.**

The Hebrew language

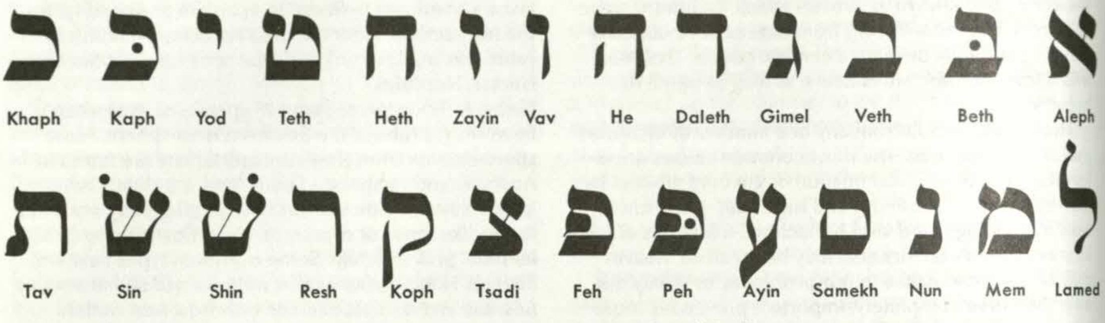
Hebrew is a dialect of Canaanite, a branch of the Northwest Semitic languages (see **Semitic languages**). In sound, it has characteristics of Arabic and Aramaic. Hebrew may be pronounced in different ways. The most widespread systems of pronunciation are the *Ashkenazic* (central European) and the *Sephardic* (Mediterranean). The main differences between the two occur in the pronunciation of certain vowels and in the accent of various words.

Words in Hebrew are written from right to left. The alphabet consists of 26 consonants, plus marks called *vowel points* that indicate vowels. Most Hebrew words are formed from roots consisting of three letters. The words are built from the roots by adding prefixes and suffixes and by changing the vowel sounds.

Hebrew literature

Beginnings. Spoken Hebrew existed by the 1300's B.C. The first known work of literature written in Hebrew was the Biblical poem "The Song of Deborah" (Judg. 5), which dates from about 1100 B.C. Along with the Bible, the other major product of early Hebrew literature was the *Talmud,* a collection of Jewish oral laws plus the interpretations of scholars (see **Talmud**). The Talmud was written from about A.D. 70 to 500. By the 500's, great verse prayers called *piyyutim* were being composed for religious services.

Medieval works. During the Middle Ages, such travellers as Eldad the Danite and Benjamin of Tudela wrote Hebrew accounts of their journeys. *Yosippon* (900's) and other anonymous works combined Jewish history with thrilling legends. Other Hebrew works of the 1100's and 1200's included the *Book of Delight* by Ibn Zabara and *Tahkemoni* by Judah Alharizi. Such writings reflect the



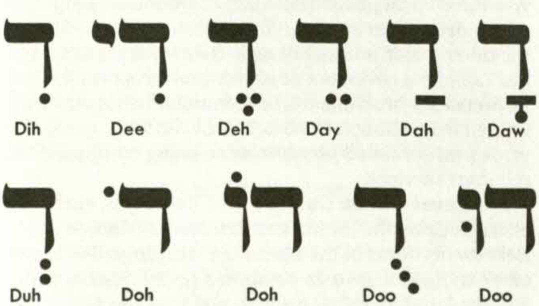
The Hebrew alphabet has 26 consonants. Five of them—Kaph, Mem, Nun, Peh, and Tsadi—are formed differently when they come at the ends of words. The illustration above shows the consonants in alphabetical order from right to left, which is the way Hebrew is read and written.

migrations of the Jews to many countries. For example, the *Book of Delight* consists of rhymed prose narratives that contain elements of *Aesop's Fables* of Greece and of tales of Arabic, Indian, and Persian origin.

A number of works of Jewish philosophy were written during the Middle Ages. The greatest of them included Judah Halevi's *Kuzari* and Maimonides' *Guide for the Perplexed,* both from the 1100's. Both of these works were originally written in Arabic and later translated into Hebrew. The *Kuzari* is a defence of Judaism in dialogue form. *Guide for the Perplexed* tries to harmonize philosophy with Jewish tradition.

The period in Spain from the 900's to the 1400's was considered a golden age of Hebrew literature, especially poetry. Hebrew poets wrote about friendship, humour, love, and war, as well as religious themes. This great poetry included the war poems of Samuel Ibn Nagrela from the 1000's and Judah Halevi's *Songs of Zion* from the 1100's.

During the Middle Ages, the Jews suffered much persecution. In 1492, for example, they were expelled from Spain. Some Hebrew authors tried to understand such Jewish suffering by examining the relationship between God and human beings. Much of the literature of these writers formed part of the Jewish mystical tradition called the *Kabbalah* (see **Mysticism**). The *Zohar (Book of Splendour),* written chiefly in the Aramaic language with some Hebrew sections, is the greatest work of Kabbalist literature. Scholars believe that most of the *Zohar* was written by Moses de Leon of Spain in the late 1200's.



Hebrew vowels are indicated by vowel points placed with a consonant. Some vowel points are shown above with Daleth.

Modern Hebrew literature, according to some scholars, began as early as the 1500's. The first important modern Hebrew cultural and literary movement was the *Haskalah* (Enlightenment), which started in the late 1700's. The Haskalah developed among the Jews of Western Europe and later spread east. Followers believed that Jews should abandon some of their traditional ways and adopt aspects of modern Western culture. Haskalah writings praised the beauty of nature and the glory of wisdom but also promoted equal rights for Jews in the non-Jewish world. See **Haskalah.**

The first Hebrew novel, *Love of Zion* (1853), was written by a Lithuanian-born author, Abraham Mapu. During the 1860's and 1870's, three writers—Yehudah Leib Gordon, Moshe Leib Lilienblum, and Peretz Smolenskin—dominated Hebrew literature. Gordon wrote poetry on historical themes and on women's rights and other issues of the time. Lilienblum was the author of a widely read autobiography, *Sins of Youth* (1876). Smolenskin was one of the first Hebrew writers to promote the idea that the Jews were a nation, not just a religious group.

Another great author of the late 1800's was Shalom Jacob Abramovich, who wrote under the name of Mendele the Bookseller. Abramovich helped develop a modern Hebrew literary style that was both precise and natural. Eliezer ben Yehudah, a journalist and dictionary writer, was the leader in reviving spoken Hebrew.

Starting in the 1880's, *Zionism,* the idea of establishing a national Jewish state, became an important force in Hebrew literature. The journalist Asher Ginsberg, also known as Ahad Haam, wrote philosophical essays on the proposed Jewish homeland. Many poems by Chaim Nachman Bialik show the excitement of the awakening of Jewish national feeling. Some of the novels and short stories of Shmuel Yosef Agnon describe the Jewish settlement in Palestine during the early 1900's. In 1966, Agnon became the first Hebrew writer to receive the Nobel Prize for literature. Other important Hebrew authors of the 1900's include the poets Yehudah Amichai, Uri Tzvi Greenberg, and Saul Tchernichovsky; and the prose writers Micha Yosef Berdyczewski, Yosef Haim Brenner, Haim Hazaz, Aharon Meged, and S. Yizhar.

A new generation of Hebrew writers began with the birth of Israel in 1948. Such works as the novels of Moshe Shamir and the poetry of Haim Guri describe life in the new nation.

Hebrew literature today deals with a variety of subjects, among them the conflict between parents and children and the rejection of some once-sacred ideas of Judaism and Zionism. Novels on such topics include Amos Oz's *My Michael* (1968) and A. B. Yehoshua's *The Lover* (1976). Other modern themes of Hebrew literature include hostility between Israelis and Arabs, and memories of the Nazi mass murder of Jews during the 1930's and 1940's.

Related articles in *World Book* include:

Agnon, Shmuel
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Bialik, Chaim
Bible
Halevi, Judah
Jews
Judaism
Maimonides, Moses
Mendelssohn, Moses
Yiddish language and literature

Hebrews. See Jews.

Hebrews, Epistle to the, is the 19th book of the New Testament in the Bible. Although it is called an *epistle* (letter), it is really a type of religious essay. Its author is unknown. It was probably written during the persecution of Christians by Rome under the Emperor Domitian sometime between A.D. 81 and 96.

The author tries to help his readers to remain faithful as Christians, despite persecution, in three ways. First, he praises the greatness of Christianity, mainly by showing that it is superior, in his view, to Judaism. Second, he presents Jesus as an example of being perfected through suffering. Third, he warns readers of the spiritual consequences of abandoning their faith.

See also **Bible** (Books of the New Testament).

Hebrides are a group of Scottish islands that lie northwest of the country's mainland. The Hebrides consist of about 500 islands and have an area of about 6,730 square kilometres. The largest islands are (1) Lewis with Harris and (2) Skye. Many of the islands are tiny and uninhabited.

The Hebrides are divided into two groups of islands, the Inner Hebrides and the Outer Hebrides, also called the Western Isles. The Inner Hebrides, which lie closest to the mainland, feature spectacular mountain scenery. The Cuillin Hills, on Skye, are especially noted for their rugged beauty. The islands of the Outer Hebrides have large areas of barren, rolling wasteland called *moors*. The Hebrides have a windy, humid climate.

A strait called the Little Minch separates these two groups of sparsely populated islands (see **Minch**). Many of the people rent small farms called *crofts* and grow barley, oats, potatoes, and other crops. Other activities include fishing, tourism, weaving, and whisky distilling. Harris Tweed, a famous brand of wool cloth, is produced exclusively in the Outer Hebrides.

People have lived in the Hebrides since prehistoric times. Norway took control of the Hebrides in the late 800's and ruled them until 1266, when Scotland gained possession of the islands. Many songs and legends have been written about the Hebrides.

Hebron (pop. 50,000) is a city in the West Bank region of Jordan (see **Jordan** [map]). Israel has occupied the West Bank since 1967.

Hebron is a marketing and administrative centre of the West Bank. It has glass-making, tanning, and food-processing plants, marble and stone quarries, and Hebron University, an Islamic university.

Mentioned in the Book of Genesis in the Bible, Hebron is one of the world's oldest cities. It has religious importance to Jews, Muslims, and Christians. It was built on the site of the Cave of Machpelah, which is believed to house the tombs of Abraham and his wife, Sarah. Abraham was the founder of Judaism and the ancestor of both the Arabs—most of whom are Muslims—and the Jews. He is also an important figure in Christianity. Today, a *mosque* (Islamic house of worship) stands above the cave. Formerly part of Palestine, Hebron became part of Jordan in 1950. Israel gained control of the West Bank during the Arab-Israeli War of 1967.

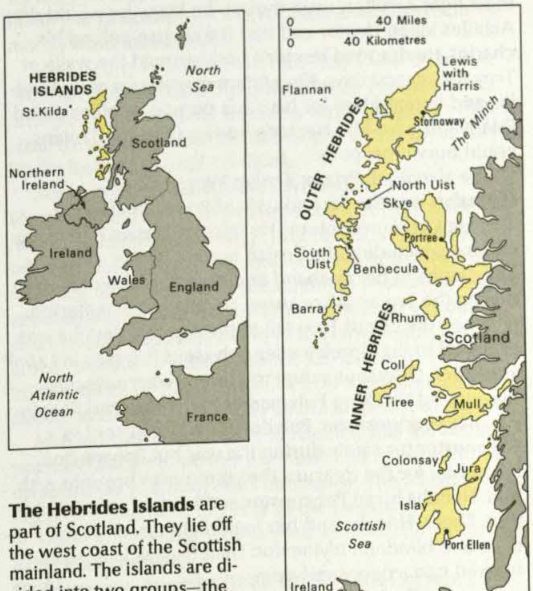
Hecate was a goddess of witchcraft and black magic in Greek mythology. Hecate became best known as a torch-bearing goddess accompanied by hellhounds. At night, she presided at crossroads, which the ancient Greeks associated with evil.

Hecate originated as a beneficial power that influenced many areas of life. Farmers, fishermen, athletes, statesmen, and soldiers prayed to her for wealth and good fortune. She was also a nurse of young children and a patron of women. Occasionally, Hecate was represented as the daughter of Demeter, the goddess of the earth and agriculture.

According to the ancient Greek writer Hesiod, Hecate's parents were *Titans,* the first divinities in Greek mythology. Hesiod described a 10-year battle in which the Olympian gods and goddesses led by Zeus defeated the Titans. Hecate alone of the Titans was allowed to retain her powers.

Hecht, Ben (1894-1964), was an American playwright, novelist, and screenwriter. Hecht wrote in a colourful style that may have been influenced by his years as a newspaperman in Chicago.

Hecht became best known for plays he wrote with Charles MacArthur. Their most famous collaboration, *The Front Page* (1928), is a comic melodrama about



The Hebrides Islands are part of Scotland. They lie off the west coast of the Scottish mainland. The islands are divided into two groups—the Outer Hebrides and the Inner Hebrides.

tough newspaper life in Chicago. Hecht and MacArthur also wrote *Twentieth Century* (1932), a fast-paced comedy about film stars. Hecht's first and best-known novel, *Erik Dorn* (1921), deals with a brilliant, cynical journalist.

Hecht was born in New York City but was raised in Racine, Wisconsin. After graduating from high school, he moved to Chicago and began working on the Chicago *Journal* as a reporter. After 1933, Hecht spent most of his time as a film screenwriter, director, and producer. He wrote scripts for such films as *Design for Living* (1933), *Nothing Sacred* (1937), *Spellbound* (1945), and *Notorious* (1946). He wrote the screenplay for *Wuthering Heights* (1939) with MacArthur. During his later years, Hecht worked hard for the establishment of the state of Israel. Hecht wrote an autobiography called *A Child of the Century* (1954).

Hectare. See **Metric system** (Surface measurements).

Hector, in Greek mythology, was the greatest hero of the ancient city of Troy. He played a major part in the Trojan War, in which Greece defeated Troy. The epic poem the *Iliad* tells of important events during the last year of the war.

Hector was the son of Priam, the king of Troy, and Hecuba. According to some myths, the Greek god Apollo was Hector's father. The *Iliad* described Hector as brave, handsome, and patriotic. During the Trojan War, Achilles, the greatest Greek warrior, refused to fight after quarrelling with Agamemnon, the commander of the Greek forces. As a result, Hector's soldiers drove the Greeks from the walls of Troy. Achilles agreed to the request of his friend Patroclus, who wanted to wear Achilles' armour and fight in his place. Hector, aided by Apollo, killed Patroclus during the battle.

Achilles returned to the battlefield to seek revenge for the death of Patroclus. The sight of Achilles terrified Hector, who tried to flee. But Hector realized that he must fight Achilles, even though he knew he would die. Achilles killed Hector and tied the corpse behind his chariot. He dragged Hector's body around the walls of Troy for several days. King Priam secretly went to Achilles and begged him for his son's corpse. Achilles pitied Priam and gave him Hector's body so that the Trojans could bury it properly.

See also **Iliad; Priam; Trojan War.**

Hecuba was the second wife of Priam, the king of Troy, in Greek mythology. Hecuba and Priam had many children, including the Trojan heroes Hector and Paris. The deaths of her husband and several of their children during the Trojan War caused Hecuba great suffering.

When the city of Troy fell to the Greeks, Hecuba was awarded to the Greek leader Odysseus (Ulysses in Latin) as a slave. Odysseus sailed to Thrace, where Hecuba discovered that King Polymestor had murdered Polydorus, her youngest son. Polydorus had been sent to Polymestor for safety during the war but Polymestor killed him for the treasure the young man brought with him. Hecuba lured Polymestor and his two sons into her tent. There, Hecuba and her handmaidens killed the children and blinded Polymestor. Hecuba was later transformed into a fiery-eyed dog.

See also **Paris** (mythology); **Cassandra.**

Hederman, Anthony James (1921-   ), was the Republic of Ireland's attorney general from 1977 to 1981. Hederman was born in Dublin. He was educated at Castleknock College and at University College, Dublin. He was called to the Bar in 1944 and to the Inner Bar in 1955. Hederman was Judge Advocate General in the Department of Defence from 1959 to 1965.

Hedge is a continuous strip of shrubs or small trees planted close together to make a boundary. Farmers in some countries grow hedges as fences to prevent farm animals from straying or to prevent wild animals from entering. Gardeners grow hedges as decorative boundaries round lawns and flower beds. Farm hedges are trimmed from time to time and may be laid (have vertical-growing branches tied down horizontally) to make them dense. Garden hedges are generally closely trimmed. Some people cut hedges into ornamental shapes (see **Topiary**). People generally make garden hedges from quick-growing evergreen shrubs that keep their shape with only little trimming. Farmers use stronger, thorny shrubs for hedges.

In Europe, farmers make hedges from *hawthorns* and *blackthorns.* In North America *honey locusts* or *Osage oranges* are commonly used for hedges. In South Africa many hedges are made from *kei apples.*

For garden hedges, people commonly use *broad-leaved privets* and kinds of *cypresses.* In Britain, *yew* is traditionally used for making hedges on estates and in parklands. Landscape gardeners use *box* plants. Decorative hedges are made from ornamental flowering shrubs, such as *berberis* in Europe, and *pittosporum* in Australia.

Hedges provide shelter, breeding and feeding areas for small mammals, birds and insects. Many songbirds nest in hedges in gardens and on farmland.

Hedge apple. See **Osage orange.**

Hedge sparrow is a bird that lives in Asia and Europe. It is also called *hedge accentor* or *dunnock.* It is a plumpish little bird with a slender bill, brown plumage streaked with black, and a grey breast, throat, and head. It has a low warbling song and a shrill call. It usually nests in hedgerows or shrubberies. It builds a cup-shaped nest of twigs, moss, and dead leaves, and lines the nest with moss and hair or wool. Its eggs are a bright turquoise blue. It feeds mainly on seeds in winter but eats many insects in summer.

Scientific classification. The hedge sparrow belongs to the accentor family, *Prunellidae.* It is *Prunella modularis.*

Hedgehog is the name of a dozen species of small, mainly nocturnal mammals that have a thick prickly coat.

Hedgehogs hunt for food at night. They eat insects, slugs, worms, small mammals, snakes, birds, and birds' eggs. When cold weather comes, hedgehogs settle down to hibernate.

The common European hedgehog is about 25 centimetres long. It has short ears and legs, a short tail and a long nose. Stiff, needlelike growths called *spines* cover its back and protect the animal from its enemies. When it is in danger, the hedgehog rolls itself into a ball. It builds a nest of grass and dead leaves. The young are born with the spines beneath the skin to avoid damaging the mother. The European hedgehog has been introduced into New Zealand.

Long-eared hedgehogs and the *desert hedgehogs* of Africa and Asia dig out burrows where they nest during the heat of the day.

The hedgehog has short, sharp spines on its back.

Scientific classification Hedgehogs belong to the order Insectivora, family Erinaceidae. The European hedgehog is *Erinaceus europeaus.* Long-eared hedgehogs are genus *Hemiechinus.* Desert hedgehogs are *Paraechinus.*

Hedging. See **Commodity exchange.**

Hedonism is the belief that pleasure is the highest good of life. The term *hedonism* comes from a Greek word meaning *pleasure.* In ancient Greece, the Epicureans and Cyrenaics based their ethical philosophies on the idea that pleasure is the highest good. But the Epicureans believed that people should seek pleasures of the mind rather than pleasures of the body. The wise person, they thought, avoids pleasures which may later cause pain. In modern philosophy, the hedonistic utilitarians believe that people should seek not their own individual pleasure alone, but the greatest good for the greatest number of people (see **Utilitarianism**).

Heel fly. See **Warble fly; Bot fly.**

Hegel, G. W. F. (1770-1831), was one of the most influential German philosophers. Hegel argued that in order to understand any aspect of human culture, we must retrace and understand its history.

Hegel's emphasis on the importance of historical understanding has greatly promoted the development of the historical study of philosophy, art, religion, science, and politics. The historical approach to human culture inspired by Hegel eventually spread far beyond the borders of Germany.

Hegel's dialectic. Hegel developed a theory of history that became known as his *dialectic.* Hegel believed that all historical developments have three basic characteristics. First, they follow a course that is necessary—that is, they could not have happened in any other way. To understand a historical development in any area of human thought or activity, we must see why it necessarily happened as it did. Second, each historical development represents not only change but progress. Third, Hegel argued that one phase of any historical development tends to be confronted and replaced by its opposite. This opposite, in turn, tends to be replaced by a phase that is somehow a resolution of the two opposed phases. These three phases of a typical dialectical development have often been called *thesis, antithesis,* and *synthesis.* But Hegel did not use those terms.

Hegel applied his dialectic to all areas of human life. For example, he argued that the attempt to achieve satisfaction through the *external* pursuit of power and property tends to be rejected in favour of the attempt to achieve an *inner* state of harmony and tranquility. This opposition between external activity and an inner nonactive state of mind can be resolved by having one's external activity emerge from a harmonious inner state. Or to take a political example, a period marked by the concentration of political power in one person tends to be followed by a period of widely distributed power. This opposition might be resolved by a period in which there is both some distribution and some concentration of power. Thus, an absolute monarchy might be replaced by an absolute democracy and, in turn, by a representative form of government.

Hegel's writings. In his first published book, *Phenomenology of Spirit* (1807), Hegel dealt with the development of "forms of consciousness." These forms of consciousness include a rich and bewildering variety of states of mind, views of the world, ethical positions, religious outlooks, types of physical activity, and forms of social organization. Hegel tried to demonstrate how they progressed in what he claimed was a necessary and historical sequence that moved through contradiction and resolution to ever greater levels of maturity.

In his second book, *Science of Logic* (1812-1816), Hegel tried to show the same sort of dialectic in the development of philosophical theories about reality. His *Encyclopedia of the Philosophical Sciences* (1817) contains his philosophic system in a condensed form. It has three sections: a shorter version of his book on logic, a "Philosophy of Nature," and a "Philosophy of Spirit." His last book, *Philosophy of Right* (1821), analyses the dialectical development of social, ethical, and legal systems. After Hegel's death, his students published his lectures on the philosophy of history, religion, and art and on the history of philosophy. They reconstructed the lectures mainly from their notes.

Life. Georg Wilhelm Friedrich Hegel was born in Stuttgart. He attended the University of Tübingen, near Stuttgart. His university teaching career began in 1801 in Jena. He was professor of philosophy at the University of Berlin from 1818 until his death.

See also **Marx, Karl** (Marx's writings).

Hegira is the name of Muhammad's journey from Mecca to Medina on Friday, July 16, 622. *Hegira* comes from an Arabic word that means *to emigrate.* During Muhammad's 10 years of preaching in Mecca, he had aroused opposition by proclaiming himself a prophet and criticizing aspects of life in the city. Finally, he decided to move to Yathrib, about 320 kilometres to the north, where he had friends. Yathrib thereafter was called *Madinatu-n-Nabi (City of the Prophet),* or *Medina.*

Muhammad's emigration to Medina was the turning point in his rise to power in Arabia and in his effort to establish his teaching and community. The Muslim calendar is dated from the year of the Hegira.

See also **Calendar** (The Islamic calendar); **Mecca; Medina; Muhammad.**

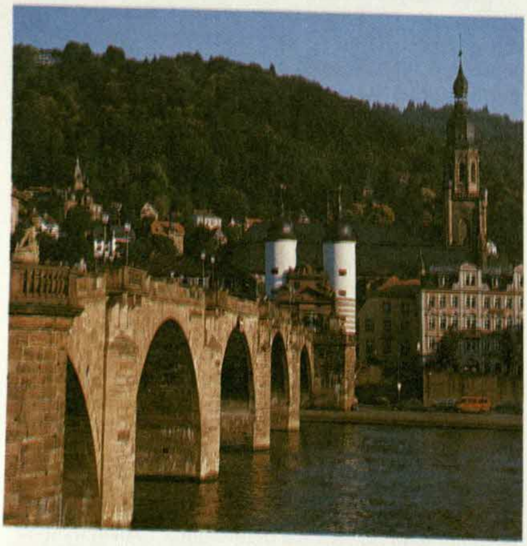
Heidegger, Martin (1889-1976), was a German philosopher who exercised a tremendous influence on the philosophers of continental Europe, South America, and Japan. His work is an attempt to understand the nature of *Being* (*Sein* in German). To study Being, Heidegger analysed human existence *(Dasein)*, because it is the form of Being that can be known best. In his attempt to understand Being, he often sought philosophical enlightenment in the *etymologies* (origins) of words. Heidegger also sought enlightenment in the insights of poets, especially his favourite poet, Friedrich Hölderlin.

Heidegger's extensive discussion of human existence, which emphasizes anxiety, alienation, and death, has led many people to call him an existentialist (see **Existentialism**). However, he denied being an existentialist, claiming that he was interested in human existence only to better understand Being. He held that the most important philosophical question is: "Why is there something rather than nothing at all?"

Heidegger was born in Baden-Württemberg. He studied philosophy at the University of Freiburg under Edmund Husserl. Heidegger succeeded Husserl in 1928, and became rector of the university in 1933. His best-known book is *Being and Time* (1927). He also wrote *What Is Metaphysics?* (1929), *Introduction to Metaphysics* (1953), and *What Is Thinking?* (1954).

Heidelberg (pop. 134,724), is a city in southern Germany (see **Germany** [political map]). Heidelberg lies in a scenic setting along the Neckar River. The ruins of beautiful Heidelberg Castle, which dates from the 1500's, stand high on a steep bank of the river and overlook the city. Concerts and an annual summer drama festival are held at the ruins. The picturesque old section of the city is the home of the University of Heidelberg. The university, which was founded in 1386, is Germany's oldest university and is one of its outstanding seats of learning. Heidelberg's quaint features have inspired romantic works about the city. Sigmund Romberg's operetta *The Student Prince* is perhaps the most famous of these works. Many tourists visit Heidelberg and contribute greatly to the economy. Products of the city include cement, precision instruments, and printing machinery.

Heidelberg was developed in the Middle Ages on the site of two monasteries. By 1693, French armies had destroyed most of the city and left the castle in ruins.



The Karl Theodor bridge spans the Neckar River at Heidelberg. Most of the earlier medieval city was destroyed by 1693.

Heidelberg, University of, is the oldest university in Germany. It was established in Heidelberg in 1386. The university has departments of biology, classical and Oriental studies, economics, history, law, mathematics, modern philology, medicine, natural sciences, philosophy, social sciences, and theology. Its library, founded in the 1500's, consists of more than a million books, including a collection of old German manuscripts. Many of the university's 26,000 students come from countries other than Germany.

The University of Heidelberg, which was modelled on the University of Paris, originally had four departments—arts, law, medicine, and theology. During the 1500's, it became the centre of Protestant learning.

The university was reorganized in 1803 and became a centre for the study of German folklore and medieval literature. The Nazis seized control of the institution in 1933 and dictated what could be taught. The university was reorganized in 1945, following Germany's defeat in World War II. It is supported by the German state of Baden-Württemberg.

Heidelberg man was a prehistoric human being who lived in Europe about 650,000 years ago. The only evidence of this creature's existence is a huge chinless jawbone with large teeth. Workers found the jaw in 1907 while digging in a sandpit in the village of Mauer, Germany, near Heidelberg. Heidelberg man belonged to an early type of prehistoric human being called *Homo erectus* (erect human being). Homo erectus appeared about 1,500,000 B.C. Scientists believe that Heidelberg man hunted now-extinct forms of buffalo, deer, elephants, elks, and rhinoceroses. Heidelberg man also probably made stone tools. See also **Prehistoric people.**

Heidelberg School was a group of young painters who worked on the tree-covered hills overlooking the Yarra River in the Melbourne suburb of Heidelberg, Australia. Leaders of the group were Tom Roberts (1856-1931), Frederick McCubbin (1855-1917), Charles Conder (1868-1909), Sir Arthur Streeton (1867-1943), and, later, Walter Withers (1854-1914). Their common aim was *plein air* (open air) impressionism as introduced to Australia from France by Roberts. French impressionists used the seven colours of the spectrum applied in small brushstrokes. Roberts adapted these principles to Australian conditions. With his friends, he set up camps, first at Box Hill, then Heidelberg or Eaglemont.

See also **Arts of Australia.**

Heiden, Eric. See **Olympic Games** (History).

Heifer. See **Cattle** (introduction; Breeding).

Heifetz, Jascha (1901-1987), was a Lithuanian-born violinist. From the time of his 1917 Carnegie Hall debut in New York City, his playing became the standard by which other violinists were measured. He recorded virtually all the great pieces written for violin and made many popular arrangements. They illustrate the highest achievement of violin and musical mastery. He often was the first person to play the works of contemporary composers.

Heifetz was born in Vilna (now Vilnius), Lithuania. His career began almost as soon as he could hold a violin and bow. When he was three years of age, his father, a violinist, began to teach him. At five, Heifetz entered the Imperial School of Music in Vilna. He later studied with the teacher, Leopold Auer, in Saint Petersburg, Russia. Heifetz began to play in public when he was six. At 13, he made his debut in Berlin and won international fame. During the Russian Revolution, Heifetz escaped to the United States. He became an American citizen in 1925.

Height and weight tables. See **Baby; Child.**

Heilbron, Sir Ian Morris (1886-1959), was a British chemist who carried out important research into vitamins A and D, steroids, and penicillin. He also helped to develop the insecticide DDT.

Heilbron was born in Glasgow, Scotland. He was educated in Glasgow and in Leipzig, Germany. He was professor at a number of universities and, during World War II (1939-1945), was scientific adviser to the Ministry of Production.

Heilbron, Dame Rose (1914-), a British barrister, was the first woman to lead the defence in a murder trial, the first woman to plead in the House of Lords, and the first woman to be appointed a *recorder* (see **Recorder**). In 1974, she became the second woman to be appointed a judge of the High Court. She was born in Liverpool and studied at Belvedere School and Liverpool University. She was called to the Bar in 1939 and became a king's counsel in 1949. She became a DBE in 1974.

Heimlich manoeuvre. See **First aid** (Choking).

Heine, Heinrich (1797-1856), ranks among the most popular writers in German literature. Several of Heine's poems are so well known they are considered part of German folklore. Heine's poetry has been set to music by such composers as Schubert, Mendelssohn, and Brahms.

Heine was born in Düsseldorf. Much of his early poetry was collected in the *Book of Songs* (1827). This collection of love poetry is Heine's best-known work and the most famous book of poetry in German literature. The poems are described as "bittersweet" because they combine simplicity and beauty with an irony that gives them a cynical tone. The most famous of the poems is "The Lorelei."

Heine's early prose is a unique combination of fiction and essay that was often imitated. Much of it was published in four volumes of *Travel Pictures* (1826-1831). Like most of Heine's writings, these are characterized by wit, irony, clarity, and intelligence.

Heine was one of the "Young Germans," a group of writers who were political radicals (see **German literature** [The young Germans]). He was attracted to the atmosphere of liberalism in France and moved to Paris in 1831. He lived there for the rest of his life. In Paris, Heine tried to bring about understanding between France and Germany, traditional enemies. He wrote a series of essays and newspaper articles to explain to the Germans the newly organized French constitutional monarchy. He described German culture to the French in *The Romantic School* (1833), *On the History of Religion and Philosophy in Germany* (1835), and other books.

Heine grew increasingly bitter about the lack of freedom in Germany and his books were banned there in 1835. He satirized the German political situation in two long mock-epic poems, *Germany: Winter's Tale* (1844) and *Atta Troll, A Midsummer Night's Dream* (1847).

Heine became paralysed in 1848 and was confined to a "mattress-grave," as he called his bed, for the rest of his life. Despite his sufferings he continued to write on cultural, political, and religious topics. He also produced two collections of poetry—*Romancero* (1851) and *Poems 1853-1854.*

Heinlein, Robert A. (1907-1988), was a popular and influential American author of science fiction. He wrote for both children and adults.

Heinlein's most popular novel, *Stranger in a Strange Land* (1961), explores controversial ideas about morality, religion, and sex. *The Past Through Tomorrow* (1967) contains a series of stories and short novels written from 1939 to 1962. Together, they describe a "future history" of the human race. Some of the characters from the future history series reappear in such Heinlein novels as *Time Enough for Love* (1973), *Friday* (1982), and *The Cat Who Walks Through Walls* (1985). Heinlein wrote several science-fiction novels for young people between 1947 and 1963 that anticipate many themes of his adult work. The best of these novels include *Rocket Ship Galileo* (1947) and *Starman Jones* (1953).

Robert Anson Heinlein was born in Butler, Missouri. He graduated from the United States Naval Academy in 1929. Heinlein served as a naval officer for five years and then worked in other fields before becoming a writer.

Heinze, Sir Bernard (1894-1982), an Australian conductor and musical scholar, made a major contribution to the development of orchestral concerts in Australia. He organized a series of regular concerts for schoolchildren, beginning in 1925. He also began youth concerts, starting in 1947.

Heinze was born in Shepparton, Victoria, Australia. He studied at the conservatory attached to Melbourne University and at the Royal College of Music in London. He was appointed professor of music at Melbourne University in 1926. He became conductor of the Melbourne Symphony Orchestra in 1933. He was director of the New South Wales Conservatorium of Music from 1957 to 1966.

Heir. Technically, an heir is a person who receives money or property left by someone who died *intestate* (without making a will). *Legatee* or *devisee* is the legal term for the beneficiary of a will. But the word *heir* is commonly used for anyone awarded an estate, whether or not the deceased person left a will.

The word *heir* comes from a Latin term that means *one entitled to inherit.* Normally, heirs are the spouse and children or grandchildren of the deceased person. If there are no surviving descendants or spouse, then parents, grandparents, brothers, sisters, or other relatives inherit. Laws vary as to who inherits and in what proportions. If there are no surviving heirs, the property normally goes to the state.

Related articles in ***World Book*** include:

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Fee
Next of kin
Personal property
Primogeniture
Property
Will

Heisenberg, Werner (1901-1976), a German physicist, is best known for his contributions to atomic theory. Heisenberg developed the *uncertainty principle,* which states that both the position and the momentum of a subatomic particle cannot be accurately determined simultaneously. He won the 1932 Nobel Prize for physics for founding one version of the field of physics called *quantum mechanics* (see **Quantum mechanics**).

Heisenberg based his theories about atomic structure on the frequencies of light given off by atoms. In 1913, the Danish physicist Niels Bohr had suggested that electrons in an atom could travel only in a certain set of orbits around the nucleus. Bohr had also shown that atoms radiate light due to changes in the arrangement of their electrons. During the early 1920's, Heisenberg used studies of atomic spectra to develop *matrix mechanics,* a form of quantum mechanics that provides a mathematical description of electron orbits.

Heisenberg discovered the uncertainty principle in 1927. This principle holds true because even the best methods used to measure the position and momentum of a moving particle disturb the particle. For example, physicists might scatter *photons* (particles of light) off a moving electron to "see" its position. But, in a collision, a photon transfers momentum to the electron. In addition, the momentum transferred to it is more uncertain. As a result, physicists cannot verify precisely both the position and momentum of the electron at the same time.

Heisenberg was born in Würzburg, Germany. He studied at the University of Munich.

Heisman Memorial Trophy is awarded annually to the outstanding college American football player in the United States. A group of sportswriters and sportscasters selects the winner of the trophy. The Heisman Trophy is sponsored by the Downtown Athletic Club of New York City.

The trophy was first awarded in 1935. The next year it was named after John W. Heisman, a leading American football coach at a number of colleges from 1892 to 1927. Heisman helped revolutionize the rules and strategy of American football. For example, he introduced the centre snap and led the campaign to legalize the forward pass.

Hejira. See **Hegira.**

Hekla is a volcanic mountain in southwestern Iceland. The mountain lies about 32 kilometres from the coast, and rises 1,491 metres above sea level. Since the 1100's, there have been about 18 eruptions on or close to Hekla. The main crater of the mountain had been quiet for over 100 years when it erupted on March 29, 1947. That eruption lasted 13 months. Lava spread over an area of 39 square kilometres, and ash fell as far away as Finland.

Heldentenor. See **Opera** (The singers).

Helen of Troy, in Greek mythology, was the most beautiful woman in the world. She was the major cause of the Trojan War, in which Greece defeated the city of Troy.

Helen was the daughter of Zeus, the king of the gods, and Leda, a human being. According to one myth, Zeus appeared in the form of a swan when he visited Leda. Helen later hatched from a swan's egg. Another myth tells that Zeus mated with Nemesis, the goddess of fate, who gave Leda the egg from which Helen was born.

When Helen was a child, an Athenian hero named Theseus fell in love with her and kidnapped her. Helen's brothers, Castor and Pollux, rescued her. Many Greek heroes courted Helen, but she married Menelaus, the king of Sparta.

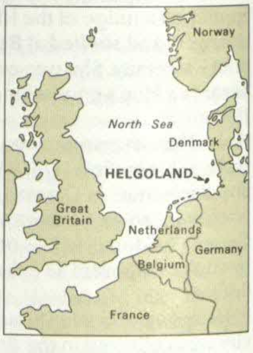
A Trojan prince named Paris visited Sparta and persuaded Helen to return to Troy with him. Menelaus' brother, Agamemnon, led a Greek army against Troy to win Helen back. Paris was killed during the war. Helen then married Paris' brother, Deiphobus, who was also killed. After the Greeks captured Troy, Helen and Menelaus were happily reunited.

According to a legend told by the poet Stesichorus, Helen never reached Troy with Paris. She and Paris travelled as far as Egypt, where she remained as the guest of King Proteus. A phantom of Helen went to Troy in her place. After the war ended, Menelaus and Helen were reunited in Egypt.

Helen's personality has fascinated writers for centuries. Some authors have portrayed her as a deceitful woman driven by passion to betray her country and family. However, other writers have regarded Helen as an innocent victim of her own great beauty.

See also **Menelaus; Trojan War.**

Helgoland is an island in the North Sea. It belongs to Germany, and covers about 2 square kilometres. It has a population of about 2,200. Great Britain ceded Helgoland to Germany in 1890 in exchange for Zanzibar in Africa. Before World War I it was a summer resort and the home of people who fished for a living. At the beginning of the war, in 1914, the people were taken to the German mainland, and the island became a naval base. The peace treaty in 1919 ordered Helgoland's fortifications and sea wall to be torn down. It later became apparent that, unless the sea walls were restored, the entire island might disappear, for one third of it had already washed away. After Hitler's rise to power, the walls were rebuilt, and Helgoland became strategically important in World War II. In 1947, the island's population was removed, and the British Navy set off 3,180 metric tons of high explosives. All the German submarine pens, underground fortifications, and all other military installations were destroyed. In 1952, Helgoland was returned to West Germany. The Germans resettled the island and built it into a resort area.



Location of Helgoland

Helichrysum is the name of daisylike flowers also known as *everlasting* or *straw flowers* because the flowerheads dry out, retain their colour and are used for flower decoration. There are about 500 species, some of them herbs and some of them shrubs. Most species are found in Australia, South Africa, and New Zealand.

Helichrysums generally grow in open sunny locations on well-drained soil. Flowers for winter decoration should be cut in bud, tied around the stalks, and hung in a cold place. The leaves of one South African species is used to make a tea called Hottentot tea.

Scientific classification. Helichrysums belong to the daisy family Compositae (Asteraceae). The widely cultivated annual helichrysum is *Helichrysum bracteatum.* Hottentot tea is made from *H. serpyllifolium.*

A heavily armed attack helicopter on a mission

A helicopter hovering over a logging site

A transport helicopter flying supplies to an oil rig

A business helicopter landing on a city rooftop

Helicopters can do jobs that aeroplanes cannot do. Unlike planes, military *attack helicopters* can turn instantly to fire weapons in almost any direction. Helicopters can hover in midair and take off and land in small areas, such as forest clearings, drilling platforms, and rooftops.

Helicopter

Helicopter is an aircraft that is lifted into the air and kept aloft by one or two powerful whirling rotors. A helicopter rotor resembles a huge propeller that is parallel to the ground. However, the rotor is actually a rotating wing. The name *helicopter* refers to the rotor. It comes from the Greek words *helix*, meaning *spiral*, and *pteron*, meaning *wing*. Nicknames for the helicopter include "chopper," "eggbeater," and "whirlybird."

A helicopter can fly straight up or straight down, forward, backward, or sideways. It can even *hover* (stay in one spot in the air). Unlike most aeroplanes, helicopters need no runway. They can take off and land in a very small space. In addition, helicopters can fly safely at much slower speeds and lower altitudes than aeroplanes. However, they cannot fly as fast as most planes. Most helicopters cannot exceed 320 kilometres per hour. At faster speeds, strong vibrations develop that could damage the rotor blades. Helicopters also use more fuel than aeroplanes to travel the same distance, and so are less economical than aeroplanes. In general, helicopters can fly for only two to three hours—or less than 1000 kilometres—without refuelling. Aeroplanes can travel much further without refuelling.

Helicopters range in size from tiny, single-seat models to huge transports that can carry two trucks in their cargo hold. The heaviest helicopter is the Mil Mi-26, built by the Soviet Union. It weighs 28 metric tons and can carry 20 metric tons of cargo.

Uses of helicopters

Helicopters can be used for many tasks that cannot be performed by other types of aircraft, because they are able to hover in midair and take off and land in small areas. They are particularly useful (1) for rescue missions, (2) for aerial observation, (3) for transportation and construction work, (4) for agricultural and forestry operations, and (5) for military missions.

For rescue missions. Many early developers of helicopters intended them to be used for saving lives. A helicopter can hover above the scene of a disaster. A sling or harness can then be lowered from the craft to endangered people below. They are then pulled up and flown to safety. Helicopters have been used to pluck people from burning skyscrapers, sinking ships, and rising floodwaters. They have flown stranded mountain climbers and injured skiers to safety. Serving as flying ambulances, helicopters can land near car or aeroplane crashes and rush the injured to hospitals. Helicopters can also deliver food and medicine to areas that other vehicles cannot reach because of earthquakes, floods, or storms.

For aerial observation. In many cities, police use helicopters to trail fleeing suspects and direct police cars on the ground. Law enforcement agents in helicopters look for lost people and escaped convicts. They may patrol national borders on the lookout for smugglers and illegal immigrants. Helicopters are also used to patrol motorways and identify speeding cars.

Many radio and television stations use helicopters to cover news events from the air. In large cities, helicopter pilots observe the flow of traffic and broadcast radio reports warning drivers of traffic jams. Film companies often film from helicopters to give audiences a bird's-eye view of a scene. Helicopter pilots fly low along pipelines, railway tracks, and power lines to inspect them for damage.

Helicopters are used to explore wilderness areas, to survey land, and to help locate oil and other resources. From helicopters, scientists count wildlife populations and chart the migration routes of wild animals. Some fishing fleets use helicopters to spot schools of tuna.

For transportation and construction work. Helicopter transportation is expensive. However, the convenience of helicopter flight makes "choppers" ideal transport vehicles for certain uses. The flexibility, security, and speed of helicopter travel have made it a major method of transportation for political leaders in many countries. Helicopter travel saves business executives time that they otherwise might waste in using slow-moving ground transportation. From *heliports* (airports for helicopters) on city office buildings, business executives may fly directly to nearby cities for meetings.

Helicopter service is essential to many offshore oil-drilling operations. Numerous offshore wells are in rough ocean waters that make it hazardous to bring in replacement crews and supplies by ship. However, helicopters can land on the drilling platforms and so provide much faster and safer delivery than ships.

Helicopters are often used to transport cargo that is too large or awkward for other vehicles to haul. The cargo is carried in a sling hanging below the craft.

Powerful helicopters are used in construction work as "flying cranes." Workers in helicopters install aerials and huge air conditioners on top of tall buildings and erect preassembled electric power transmission towers. Workers also use helicopters to pour concrete in hard-to-reach places and to put long bridge sections in position.

For agricultural and forestry operations. Farmers use helicopters to spread seeds, fertilizers, weedkillers, and insecticides over large areas. Instead of building roads, some companies that manufacture forest products depend on helicopters to transport logging crews into and out of forests and to carry out logs.

Crop-dusting by helicopter enables farmers to spray agricultural chemicals exactly where they are needed. This specially equipped helicopter is spraying a field with insecticide.

Helicopter rescue missions have saved the lives of thousands of people. A coast guard helicopter *above* has picked up the crew members from a sinking ship.

For military missions. In the armed forces, helicopters serve as flying ambulances and as troop transports. Powerful military helicopters carry artillery to key battle positions and fly jeeps, tanks, and other equipment wherever they are needed. Helicopters equipped with electronic gear pick up and disrupt enemy communications signals. The armed forces also use helicopters to observe the movements of enemy troops and ships. Many naval helicopters have devices to locate and track submarines. They may also be armed with depth charges, missiles, or torpedoes. Army *attack helicopters* may carry bombs, cannons, machine guns, or missiles. Their main targets are enemy tanks.

Types of helicopters

Single-rotor helicopters are the most common type of helicopters. A single-rotor helicopter has one main rotor mounted above its body. Although such an aircraft is called a single-rotor helicopter, it also has a second, smaller rotor mounted on its tail. The main rotor may have from 2 to 8 blades. It provides the helicopter's lift-

An antisubmarine helicopter, armed with torpedoes, takes off from a navy ship. Such helicopters carry electronic devices to locate and track submarines.

ing power. The tail rotor has from 2 to 13 blades. It is mounted vertically on either side of the tail and so spins at a right angle to the main rotor. The tail rotor is used to control direction. It also overcomes the tendency of the helicopter to spin around in the direction opposite to that of the main rotor.

Twin-rotor helicopters have two main rotors. The rotors turn in opposite directions and so eliminate the need for a tail rotor. Two basic types of twin-rotor helicopters are widely used: *tandem-rotor helicopters* and *coaxial-rotor helicopters*. A tandem-rotor helicopter has a main rotor mounted above each end of its body. A coaxial-rotor helicopter has one rotor above the other. The rotors are mounted above the middle of the helicopter's body. The shaft of the upper rotor turns inside the shaft of the lower rotor.

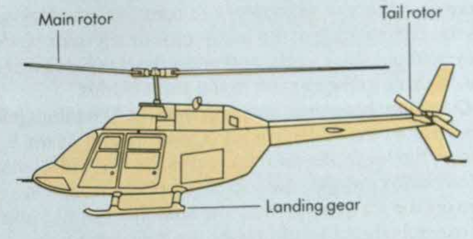
How helicopters fly

Lift is the force that causes an aircraft to overcome gravity, climb into the air, and stay aloft. Most aircraft rely on wings to produce lift. An aeroplane has *fixed* (immovable) wings that create lift as the aeroplane moves forward. Helicopter rotor blades are *rotary wings*. An engine turns the rotor, and the blades generate lift as they whirl through the air.

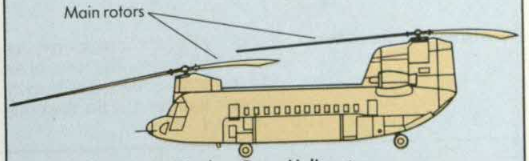
The special shape of wings helps them create lift. A wing's upper surface is curved, and its lower surface is less curved or flat. As a wing moves or whirls through the air, air flows over and under the wing. In the same amount of time, the air flowing over the curved upper surface travels farther than the air flowing under the wing. The air thus flows faster over the wing than under it. This difference in air speed creates a difference in air pressure above and below the wing. There is less pressure on the upper surface than on the lower surface. Because air is pushing more strongly against the bottom of the wing than against the top, lift is created. For additional information, see the article **Aerodynamics** (Principles of aerodynamics).

Helicopter pilots, like aeroplane pilots, can control the amount of lift by changing the angle that the wings make with the airflow. This angle is called the *angle of attack*. You can demonstrate the relation between lift and the angle of attack by using a kite to serve as a simple wing. Hold the kite flat and point it into the wind. If you then slightly raise the front of the kite, you increase the angle of attack. You will feel a force trying to push the kite upward. This force is the lift created by the wind as it pushes against the bottom surface. If you decrease the angle of attack, the force becomes weaker.

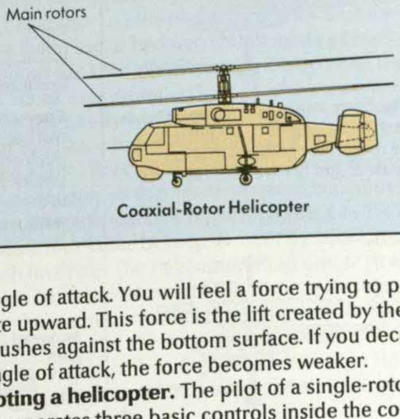
Types of helicopters



Single-Rotor Helicopter



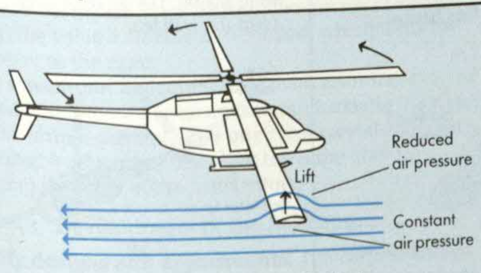
Tandem-Rotor Helicopter



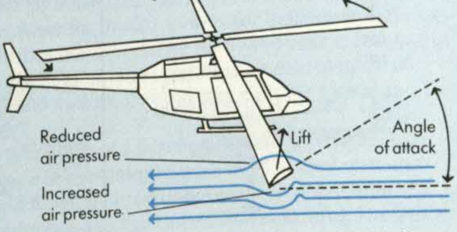
Coaxial-Rotor Helicopter

Piloting a helicopter. The pilot of a single-rotor helicopter operates three basic controls inside the cockpit. (1) The *collective pitch lever* makes the helicopter climb,

How a helicopter rotor produces lift



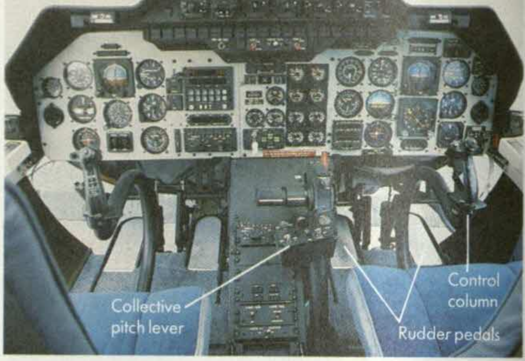
A rotor blade's shape creates lift. As the blade moves, air flows faster over its curved upper surface than under its flat lower surface. Air pressure is thereby reduced over the blade but unchanged under it. This difference in pressure produces lift.



Greater lift can be created by increasing the *angle of attack*—the angle the rotor blade makes with the air flowing past it. Increasing the angle causes air to push against the bottom of the blade, which increases the air pressure and thereby the lift.

hover, or descend. (2) The *control column*, also called the *cyclic pitch control*, causes it to fly forward, backward, or sideways. (3) The *rudder pedals* swing the tail around so that the helicopter can turn. Each control varies the *pitch* (angle) of the main rotor or tail rotor blades. A system of cables, rods, and other devices leads from the controls in the cockpit to the rotor blades.

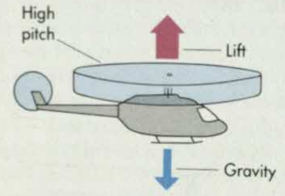
Climbing, hovering, and descending. The pilot's left hand moves the collective pitch lever up and down. By raising the lever, the pilot increases the pitch of all main rotor blades equally. The increased pitch, in turn, increases the lift generated by the spinning rotor. When lift exceeds the force of gravity, the helicopter goes straight up. After reaching a particular altitude, the pilot may want to hover. The pilot then lowers the lever to decrease the pitch of the rotor blades and so reduce



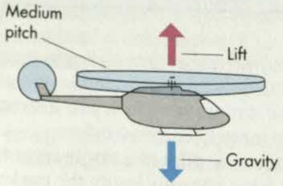
Helicopter controls. Moving the *collective pitch lever* makes the helicopter climb, hover, or descend. Tilting the *control column* causes forward, backward, or sideways flight. Pushing the *rudder pedals* controls the direction the helicopter points. This photo shows a craft with dual controls for the pilot and copilot.

Piloting a helicopter

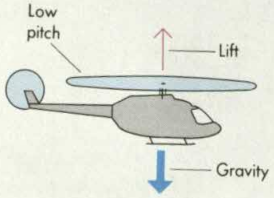
A pilot flies a helicopter by varying the *pitch* (angle) of the rotor blades. The lift of the main rotor counteracts gravity. The force of the tail rotor counteracts *torque*, a force that tends to spin the aircraft in the direction opposite to that of the main rotor. In the diagrams below, the pitch of the blades is indicated by the thickness of the circles showing the area swept by the rotor.



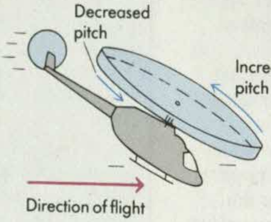
Climbing. Raising the collective pitch lever increases the pitch of the main rotor blades. Lift is increased, and the craft climbs.



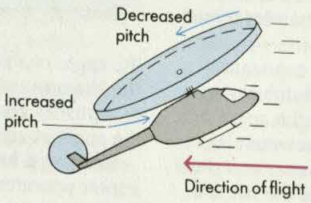
Hovering. Holding the collective pitch lever so the blades have medium pitch produces just enough lift to counteract gravity. The craft then hovers.



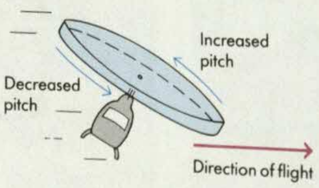
Descending. Lowering the collective pitch lever decreases the pitch. The blades create little lift, and gravity causes the helicopter to descend.



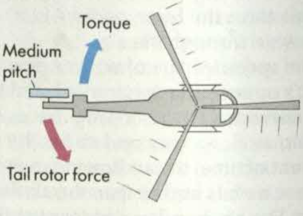
Forward flight. Tilting the control column forward makes the pitch greatest as the blades approach the tail. The rotor tilts up in the rear and the craft flies forward.



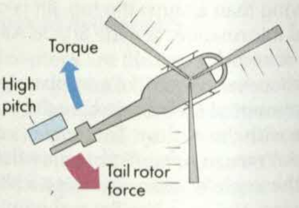
Backward flight. Tilting the column back makes the pitch greatest as the blades approach the nose. The rotor tilts up in the front and the craft flies backward.



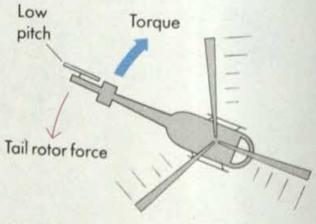
Sideways flight. Tilting the column to one side makes the rotor tilt up on the opposite side. The craft then flies in the direction the column is tilted.



Pointing straight. If neither rudder pedal is pushed, the tail rotor force balances the torque. The helicopter then points straight ahead.



Turning left. Pushing the left rudder pedal increases the pitch, and thus the force, of the tail rotor blades. The tail rotor force turns the craft left.



Turning right. Pushing the right rudder pedal decreases the pitch, and thus the force, of the tail rotor blades. Torque then swings the craft to the right.

the amount of lift. When the rotor's lifting force has been reduced just enough to counteract the pull of gravity, the craft will maintain a constant altitude. To descend, the pilot lowers the collective pitch lever farther, thereby decreasing the lift. When lift becomes weaker than the force of gravity, the craft descends.

Flying forward, backward, and sideways. The pilot's right hand operates the control column. The control column is a stick between the pilot's knees. It can be tilted in any direction. The helicopter moves in whatever direction the pilot tilts the column.

When the control column is tilted, the pitch of the main rotor blades alternately increases and decreases as they sweep through opposite sections of their circular path. To fly forward, the pilot pushes the column ahead. This causes the pitch to be greatest just before the blades pass over the tail. The blades have the least pitch just before they reach the nose. These changes in pitch cause the rotor blades to rise slightly in the rear. The rotor then tries to pull the helicopter both upward and ahead. Gravity counteracts the upward pull, however, and so the aircraft moves forward in level flight.

To fly backward, the pilot pulls back on the control column. This gives the blades the most pitch as they approach the nose and the least pitch as they approach the tail. The nose rises, the tail dips, and the helicopter flies backward. The aircraft can be made to fly sideways in a similar manner.

Turning. As a helicopter's main rotor spins in one direction, it creates a force that pushes against the body of the craft in the opposite direction. This twisting force is called *torque*. It must be overcome or the helicopter will be out of control and simply turn in circles.

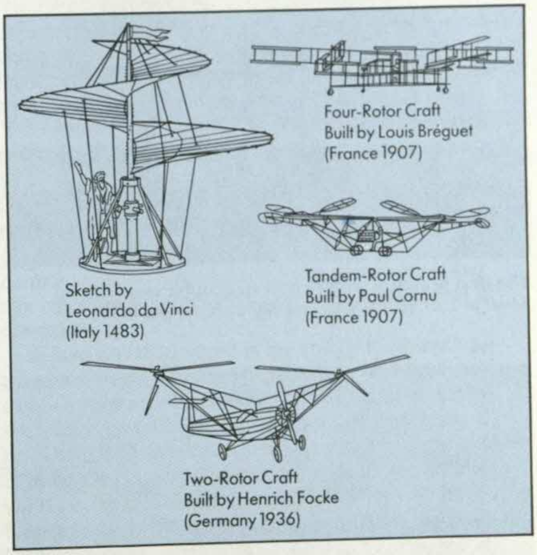
The main rotor of a single-rotor helicopter spins in a counterclockwise direction, and so the push of the torque is clockwise. The pilot of a single-rotor craft uses the tail rotor to counteract torque and to change direction. The pilot controls the tail rotor by stepping on two rudder pedals. If neither pedal is depressed, the tail rotor blades spin at just the right pitch to produce exactly enough sideways force to counteract the torque. The helicopter then points straight ahead. To swing left, the pilot steps on the left rudder pedal, thereby increasing the pitch of the tail rotor blades. The increased force of the rotor pushes the tail in the direction opposite to the clockwise push of the torque. The helicopter then turns to the left. To turn right, the pilot depresses the right rudder pedal and so decreases the pitch—and thus the force—of the tail rotor blades. The torque itself then swings the tail in a clockwise direction, which turns the helicopter to the right.

On a twin-rotor helicopter, one main rotor turns clockwise and the other turns counterclockwise. As a result, the torque generated by one rotor cancels out that generated by the other. The pilot turns the craft by changing the pitch of the main rotors.

Development of the helicopter

Early designs and experiments. The earliest known mention of a rotor-powered flying machine appears in a Chinese text written about A.D. 320. The design of this machine may have been based on a Chinese toy called the *flying top*. Such toys flew by means of feather rotors. In 1483, the great Italian artist and scientist Leonardo da Vinci sketched a design for a helicopter. It had a large screwlike wing made of starched linen. In 1784, two Frenchmen named Launoy and Bienvenu built the first model helicopter in Europe that could fly. Based on the Chinese flying top, it had two rotors made of feathers. Throughout the 1800's, inventors in Europe and the United States experimented with model helicopters. The steam engines and electric motors of that time were too weak or too heavy to power a full-sized helicopter.

Early helicopters



By the early 1900's, small, powerful petrol engines had been developed that made manned helicopter flight possible. The first manned flight took place in 1907. The craft was a four-rotor helicopter built by Louis Bréguet, a French inventor. The helicopter lifted one of Bréguet's assistants 61 centimetres into the air for a minute. Assistants on the ground steadied the helicopter during the flight. Later in 1907, a French mechanic named Paul Cornu made the first free flight in a helicopter. He flew his tandem-rotor aircraft to a height of about 2 metres for about 20 seconds.

The first practical helicopters. Early helicopters were difficult to control, and their flight was wobbly. In 1935, Bréguet and another Frenchman, René Dorand, built a coaxial-rotor helicopter that was easier to control and flew far more steadily. In 1936, Heinrich Focke, a German inventor, built a twin-rotor helicopter that was even further advanced. The following year, it reached a speed of 122 kilometres per hour and an altitude of about 2,400 metres. It could stay aloft for 1 hour and 20 minutes.

The first flight of a practical single-rotor helicopter took place in the United States in 1939. The craft was built and flown by Igor I. Sikorsky, a Russian engineer who had moved to the United States in 1919. The British and the U.S. armed forces used an improved version of Sikorsky's helicopter during World War II (1939-1945).

Further improvements. During the mid-1900's, the military use of helicopters began to increase greatly, which led to major improvements in their design. Heli-

The first practical single-rotor helicopter was built and flown by Igor Sikorsky. Its first flight, *above*, was in 1939.

Helicopters in combat were first used on a massive scale by United States armed forces during the Vietnam War (1957-1975).

An experimental compound helicopter has coaxial rotors to provide lift. However, it uses jet engines for forward movement. Such aircraft can fly much faster than regular helicopters.

copters had been used mainly for patrol and rescue missions in World War II. New tasks for the helicopter during the Korean War (1950-1953) included armed observation of enemy positions and strength and transporting troops and supplies to hard-to-reach areas. During the Vietnam War (1957-1975), thousands of armed U.S. attack helicopters flew combat missions.

The ever-expanding military use of helicopters encouraged the development of faster, larger, and more powerful craft. In the 1940's and 1950's, engineers adapted the jet engine for use in helicopters. Jet engines were lighter and more powerful than the previous engines used to turn the rotor shafts. They enabled helicopters to fly faster and higher and to carry heavier loads. In addition, the use of new construction materials made helicopters lighter, safer, and stronger. For example, metal or wooden rotor blades were replaced by longer-lasting plastic blades. Such improvements also made helicopters suitable for more civilian uses.

Recent developments include efforts by manufacturers to simplify the complicated operation of helicopters and to increase their speed. One manufacturer has developed a single-rotor helicopter that needs no tail rotor. Instead, the craft uses jets of air to counteract torque and to change direction. Attempts to increase the speed of helicopters have led to the development of experimental *compound helicopters.* These vehicles do not depend entirely on rotors to provide forward movement as well as lift. Instead, compound helicopters also have jet or propeller systems to help push or pull them ahead. One compound helicopter has reached the speed of 555 kilometres per hour.

Related articles in ***World Book*** include:

Aerodynamics
Autogiro
Cayley, Sir George
Sikorsky, Igor I.
V/STOL

Outline

I. Uses of helicopters
  A. For rescue missions
  B. For aerial observation
  C. For transportation and construction work
  D. For agricultural and forestry operations
  E. For military missions
II. Types of helicopters
  A. Single-rotor helicopters
  B. Twin-rotor helicopters
III. How helicopters fly
  A. Lift
  B. Piloting a helicopter
IV. Development of the helicopter

Questions

What kind of wings does a helicopter have?
How are helicopters used in the construction industry?
What is a *tandem-rotor helicopter*? A *coaxial-rotor helicopter*?
Who built and flew the first practical single-rotor helicopter?
What are some military uses of the helicopter?
Why does a single-rotor helicopter have a tail rotor?
What is a *compound helicopter*?
In what ways can a helicopter fly that an aeroplane cannot?
What happens when a helicopter pilot raises the collective pitch lever?
Why is helicopter service essential to many offshore oil-drilling operations?

Heliograph was an instrument used to send signals by reflecting sunlight with a mirror or mirrors. Heliographs were used by the armies of several countries during the late 1800's.

The heliograph had a mirror with a sighting rod—or else two mirrors— mounted on a tripod. A screen or shutter for interrupting the flashes was mounted on another tripod. If the sun was in front of the sender, its rays were reflected directly from a mirror to the receiving station. The sender used the sighting rod to line the flash up with the receiver. If the sun was behind the sender, its rays were reflected from one mirror to another, and from the second mirror to the receiver. The flash was lined up with the receiver by adjusting the two mirrors. Messages were sent as short and long flashes by opening and closing the shutter. The flashes represented the dots and dashes of the Morse code.

The distance that heliograph signals could be seen depended on the clearness of the sky, the length of un-interrupted sight, and the size of the mirrors used. Under ordinary conditions, a flash could be seen 48 kilometres away with the naked eye and much farther off with a telescope.

See also **Morse code.**

Helios was the sun and god of the sun in Greek mythology. His sisters were Selene (the moon) and Eos (dawn). The Greeks believed Helios, accompanied by Eos, drove a four-horse chariot across the sky each day. Each evening, a huge golden cup brought him back to his palace in the east on the river Oceanus. His daily journeys made him an all-seeing god, and Greeks often called upon him to witness their oaths. The island of Rhodes was sacred to Helios and a statue of him stood there.

See also **Seven Wonders of the Ancient World** (The Colossus of Rhodes); **Phaëthon.**

Heliotrope is a popular plant with beautiful, fragrant flowers. These flowers always face toward the sun. Another name for heliotrope is *turnsole.* Both names mean *turning to the sun.*

The species of heliotrope grown in most places is native to Peru. It grows easily from cuttings or from seed. The plant is shrubby, has many branches, and grows from 30 to 60 centimetres high. The oval leaves have veins and wrinkles. The tiny, sweet heliotrope blossoms form huge clusters that range from lilac to dark blue in colour. Each flower is shaped like a slender tube that broadens into a five-pointed star. The fragrance of the Peruvian heliotrope is like vanilla. Another kind smells like narcissus. Heliotrope perfumes imitate this scent.

The heliotrope produces beautiful, fragrant flowers. The star-shaped blossoms form large, colourful clusters on the plant.

Scientific classification. Heliotropes are members of the borage family, Boraginaceae. They make up the genus *Heliotropium.*

Helium, a chemical element with the symbol He. It is a lightweight gas and chemical element. Hydrogen is the only element that weighs less than helium. Helium is called an *inert gas* or *noble gas.* These terms are used because helium does not combine with other elements (see **Noble gas**).

Helium makes up only a small fraction of the earth's matter. But it is one of the most common elements in the universe. The sun and other stars are made mostly of helium and hydrogen. The energy of these stars is produced when hydrogen atoms *fuse* (join together) to form helium atoms. This process is also what gives the hydrogen bomb its energy (see **Nuclear weapon**).

On the earth, helium occurs in natural gas deposits and in the atmosphere. The atmosphere contains about 5 parts of helium per million parts of air. Because helium is so light, it constantly escapes from the atmosphere and drifts into space. But the lost helium is replaced by radioactive minerals that shoot out *alpha particles* (helium nuclei). Each alpha particle captures two electrons to form a complete helium atom. See **Radioactivity.**

Helium was discovered in the sun by the French astronomer Pierre J. Janssen in 1868. Janssen found evidence of helium while studying a solar eclipse. Sir Joseph Lockyer, an English astronomer, and Sir Edward Frankland, an English chemist, suggested the name helium for the element. The name comes from the Greek word *helios,* meaning sun. In 1895, helium was first found on the earth. The Scottish chemist Sir William Ramsay and the Swedish chemists Nils Langlet and Per Theodor Cleve discovered it in the mineral clevite.

Uses. A major use of helium is in maintaining the proper pressures in rockets. Pressure must be maintained in rocket fuel tanks during flight, or the thin walls of the large tanks might collapse as the fuel drains from them. Helium also produces the pressure that forces fuel into rocket pumping systems.

The largest industrial use of helium is in *heliarc welding* (a type of electric arc welding). The inert helium keeps oxygen in the air from reaching the metal. If oxygen reaches the metal, it may cause the metal either to burn or to corrode. Helium is used to prevent chemicals from reacting with other elements during storage, handling, and transportation.

Helium is also used to fill scientific balloons. The balloons rise to high altitudes, because helium is lighter than air. In air, helium has 92 per cent of the lifting ability of hydrogen. It is safer than hydrogen because it will not burn, as hydrogen will.

Persons with asthma or other breathing difficulties must sometimes inhale a mixture of helium and oxygen. The mixture enters the lungs more easily than air because the helium atoms are lighter than the nitrogen molecules of the air. Divers sometimes breathe a mixture of helium and oxygen to avoid a painful illness called *nitrogen narcosis.* Nitrogen narcosis usually occurs at depths below 30 metres. The pressure of the water on divers' bodies forces bubbles of nitrogen gas from the air into their blood when they breathe. The blood carries the nitrogen to the brain. This illness causes the divers to lose the ability to think clearly, and they may do dangerous things or pass out.

Production. Most of the world's helium comes from five natural-gas fields in the United States: (1) the Cliffside field in the Texas Panhandle, (2) the Greenwood field in Kansas and Colorado, (3) the Hugoton field in Kansas, Oklahoma, and Texas, (4) the Keyes field in Oklahoma, and (5) the Panhandle field in Texas. These fields contain an estimated 5 billion cubic metres of helium. Helium plants in the United States produce about 57

Helium has several uses. In heliarc welding, *above,* a blanket of helium is blown over certain metals to protect them from oxygen in the air. A diver, *left,* sometimes breathes a mixture of helium and oxygen to prevent an illness called *nitrogen narcosis.*

million cubic metres each year. Helium is also found in parts of Canada, Russia, the Sahara Desert, and South Africa.

Natural gas from some wells contains up to 8 per cent helium. Helium is purified by cooling the natural gas until all gases except helium, argon, hydrogen, and nitrogen change to liquid. Hydrogen is then burned out of the remaining mixture, and argon is absorbed by charcoal at low temperatures. Nitrogen often remains in helium as an impurity. Helium that is 99.995 per cent pure is called *grade A* helium. *Crude* helium contains about half helium and half nitrogen.

Properties. Helium is a colourless, odourless, and tasteless gas. Its atomic number is 2 and its atomic weight is 4.00260. Helium has a density of 0.0001664 grams per cubic centimetre at 20° C. It changes to liquid when it is cooled to −268.9° C, about 4° C above absolute zero. Because helium can be cooled to such a low temperature without freezing, it is used as a liquid refrigerant in low temperature devices and in cryogenics research (see **Cryogenics**). In addition, helium is the only chemical element that cannot be changed to a solid by cooling alone under ordinary pressures. It must be cooled and compressed. Helium freezes solid at −272.2° C under a pressure of 26 times atmospheric pressure.

Liquid helium is one of the strangest of all liquids. Unlike most liquids, it conducts heat extremely well, it flows toward relatively warm places, and it expands instead of contracting when it cools. Liquid helium forms a film over everything it touches. This film can act as a siphon, carrying helium over the side of a container to a lower level.

See also **Airship; Balloon; Element, Chemical** (Periodic table); **Ramsay, Sir William.**

Hell, according to many religions, is a place or state inhabited by demons, where wicked people are punished after death. Hell also is a symbol of the most powerful opposition to goodness and justice.

In Old Testament times, the Jews believed that all the dead, both good and evil, went to a dark, unhappy place called *Sheol.* By the time of Christ, some Jews thought that the wicked were separated from the righteous and then cast into a foul, burning valley called *Gehenna.*

Hell is no longer prominent in the teachings of Judaism, but Gehenna became the hell of Christianity and Islam. According to traditional Christian belief, hell is a place of unending anguish and pain caused by the loss of happiness. However, some Christian theologians have argued that hell is not a real place but a symbol of the anguish caused by the loss of God or goodness. Islam, the religion of the Muslims, regards hell as a vast, fiery crater that the souls of the dead cross on a narrow bridge. The wicked fall off the bridge into everlasting torment.

In Hinduism and Buddhism, a soul may descend into one of many hells as a result of wicked *karma* (thoughts, words, and deeds). The stay in hell is not eternal. It lasts only until the effects of the evil karma have been removed.

See also **Religion** (A doctrine of salvation); **Divine Comedy; Hades; Limbo; Purgatory.**

Hellebore is the common name of a genus of plants in the buttercup family. They are found in Europe and Asia. Hellebores are perennials. They have thick, fibrous roots and large flowers. The *Christmas rose,* or *black hellebore,* blooms from late autumn to early spring. Its white or pale purple flowers look like single roses. Its roots and leaves contain a powerful poison.

Stinking hellebore is named after its strong smelling green flowers. The *lenten rose* of Greece and Turkey has cream flowers speckled with crimson, but the flowers can also be purple or pink. Hellebores prefer a deep, rich, moist, but well-drained soil. Most species do best in part shade.

Scientific classification. Hellebores belong to the buttercup family, Ranunculaceae, genus *Helleborus.* The Christmas rose is *H. niger,* the stinking hellebore is *H. foetidus,* and the lenten rose is *H. orientalis.*

Hellenes. See **Greece, Ancient.**

Hellenistic Age was a period in ancient history when Greek culture dominated much of what was then the civilized world. It began after the death of Alexander the Great in 323 B.C., and lasted nearly 200 years in Greece and almost 300 years in the Middle East. The term *Hellenistic* is used to distinguish this period from the earlier Greek classical or *Hellenic* period.

The Hellenistic Age was a period of great achievement in scholarship, science, and the arts. For example, the mathematician Euclid developed the principles of geometry, and the inventor Archimedes discovered many basic laws of physics. The astronomer Aristarchus of Samos suggested that all the planets, including the earth, revolve around the sun. The mathematician Eratosthenes made a nearly correct calculation of the earth's circumference.

Paintings and sculpture became more realistic. Hellenistic sculptors created such masterpieces as the *Laocoön* and the *Winged Victory of Samothrace.*

Philosophers of the period were concerned with how people could achieve peace of mind. The major groups of Hellenistic philosophers were (1) the Stoics, (2) the Epicureans, and (3) the Cynics. *Stoics* believed that happiness resulted when people learned to accept events beyond their control and did their duty. *Epicureans* sought pleasure in moderation and avoidance of pain. *Cynics* tried to disregard all desires and pleasures, and pursued virtue. For religion, many people worshipped such Egyptian divinities as Isis and Serapis.

Earlier, Greece had been divided into independent *city-states,* each of which consisted of a city and its surrounding territory. During the Hellenistic Age, the city-states lost their independence. They came under the control of monarchies that governed large kingdoms. Some monarchs claimed to rule by divine right.

The major dynasties of the age were the Ptolemies of Egypt, Antigonids of Macedonia, Seleucids of Syria, and Attalids of Pergamum (now western Turkey). They fought against each other and among themselves. This disunity helped the Romans conquer most of the Hellenistic world in the 100's B.C.

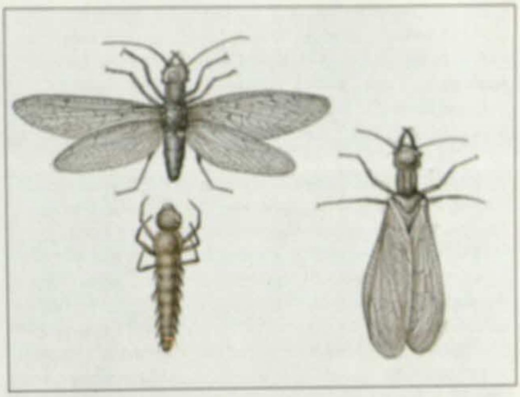
See also **Greece, Ancient** (The Hellenistic Age); **Sculpture** (Hellenistic sculpture).

Heller, Joseph (1923-), is an American novelist who established his reputation with the comic novel *Catch-22* (1961). The title describes the accumulated absurdities that characterize some complex organizations. The organization in *Catch-22* is the military. The novel is set during World War II and describes the misadventures of Yossarian, a U.S. officer. His ways of retaining his identity depend on his ability to manoeuvre within an absurd and illogical system. In *Something Happened* (1974), Heller described the psychological pressures faced by an American business executive. *Good as Gold* (1979) describes the personal and professional problems of an American college professor. *God Knows* (1984) is a comic novel written in the form of an autobiography of the Biblical leader King David. With Speed Vogel, Heller wrote *No Laughing Matter* (1986), an autobiographical account of Heller's battle against a paralysing illness.

Heller was born in Brooklyn, New York. He has been a teacher, an advertising writer, and a magazine promotion manager.

Hellespont is the former name of the strait between the Sea of Marmara and the Aegean Sea. Today, this strait is called the Dardanelles. The Hellespont was named after the mythical Helle, daughter of Athamas, king of Thessaly. Helle and her brother Phrixus ran away from their stepmother. They were flying across the sea on the ram of the Golden Fleece, when Helle fell and drowned. According to legend, Leander swam the Hellespont each night to see Hero, with whom he was in love. See also **Dardanelles; Hero and Leander.**

Hellgrammite is the larva of a four-winged insect known as the dobsonfly. Hellgrammites live under stones in swift streams of North America. They have strong jaws and prey upon small water animals. They are a popular bait for bass fishing because they wriggle about. When hellgrammites are fully grown they leave the water, pupate for about two weeks, and emerge as dobsonflies.



Hellgrammite is the large black larva of an insect called the dobsonfly. Hellgrammites live in swift streams in North America.

Scientific classification. Dobsonflies belong to the order Neuroptera. They are *Corydalus cornutus.*

Hellman, Lillian (1905-1984), was an American playwright. Her work combines tightly woven plots with insight into psychological weakness and a deep concern for the social issues of her time.

Hellman's plays of the 1930's and 1940's focus on destructive selfishness and greed. In *The Children's Hour* (1934), a spoilt, disturbed girl ruins the lives of two women teachers by spreading rumours that they have a lesbian relationship. In *The Little Foxes* (1939), material greed and lust for power create tragic conflicts in a Southern American family. *Another Part of the Forest* (1946) shows the roots of the family's materialism in the deeds of the preceding generation. The family symbolizes Hellman's disapproving view of the immorality she saw unleashed by America's materialism and by the dominance of greed over humane values. In *Watch on the Rhine* (1941), the destructive evil of the Nazis disrupts the sheltered lives of a family in suburban Washington, D.C. Hellman's other plays include *The Autumn Garden* (1951) and *Toys in the Attic* (1960).

In the 1970's, Hellman achieved new recognition for her autobiographical writings. They include *An Unfinished Woman* (1969), an autobiography; *Pentimento* (1973), a series of portraits of people she had known; and *Scoundrel Time* (1976). This last book is a memoir of Hellman's involvement in congressional investigations of Communist influence in the United States. Her final autobiographical work was *Maybe* (1980). Hellman was born in New Orleans, Louisiana.

Hellyer, Henry (1792-1832), an Australian explorer, investigated the Mersey River area of Tasmania, Australia, in 1826. He was accompanied by Clement Lorymer. The two men were trying to find suitable grazing land for the Van Diemen's Land Company. They were forced to turn back near Mt. Roland, but reported good land towards St. Valentine's Peak. In 1827, Hellyer investigated this land and discovered the Surrey and Hampshire Hills and the Hellyer and Arthur rivers. He recommended Emu Bay, the present site of Burnie, Tasmania, as an outlet for settlement. He also constructed roads and stock routes.

Helmet is a covering of metal or other sturdy material designed to protect the head. Most helmets have a soft lining so they may be worn comfortably. Many people wear helmets, including firemen, police, motorcyclists, and construction workers. Some athletes wear helmets. Astronauts wear special helmets for space travel. In tropical climates, *pith helmets* or *cork helmets* provide protection from the sun.

Helmets once were worn only in war. The first helmets, worn by Ethiopian soldiers, were the skulls of horses, complete with mane and ears. The ancient Assyrians, Greeks, and Romans wore dome- or cone-shaped helmets made of bronze. Knights in the Middle Ages wore helmets of chain mail or plated steel. They were dome-shaped so that sword blows glanced off the surface. In many cases, the helmet covered the entire head, leaving only slits or holes for seeing and breathing. Some helmets were attached to body armour so they could not be knocked off.

Combat soldiers in World Wars I and II wore steel helmets that could also be used as a cooking pot, dish, or wash basin.

See also **Armour**; **Bronze** (picture: Bronze helmet, Greece).

Helmholtz, Hermann Ludwig Ferdinand von (1821-1894), a German physicist, helped prove the law of the conservation of energy (see **Energy** [The conservation of energy]). His research on sound ranked as the outstanding work of his time in acoustics. He was the first to apply physical methods to the study of the nervous system by measuring the speed of nerve impulses. Helmholtz also invented the ophthalmoscope, used by doctors to examine eyes. He was born in Potsdam. See also **Colour** (The three-component theory); **Ophthalmoscope**; **Heat** (Learning about heat).

Helpmann, Sir Robert (1909-1986), an Australian actor, ballet dancer, and choreographer, was a principal dancer with the Vic-Wells Ballet from 1935 to 1950. During this time, he toured Europe and North America. He became one of the principal choreographers for the Sadler's Wells Ballet (now the Royal Ballet) in 1943. He created the ballet *Yugen* for the Australian Ballet Company in 1964 and became co-artistic director of the company in 1965.

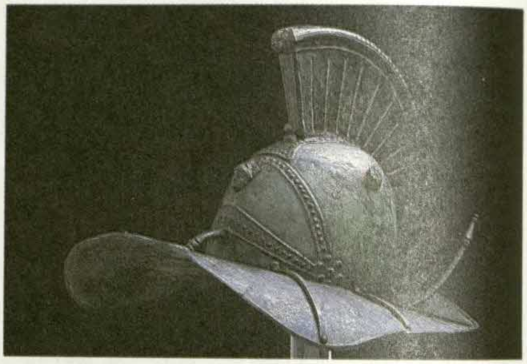
During his acting career, he played leading parts in many plays by Shakespeare. He first appeared with the Old Vic in 1937 in *A Midsummer Night's Dream.* He led the Old Vic Australian tour in 1955 and directed the

The Metropolitan Museum of Art, New York City

Greek helmet

The Metropolitan Museum of Art, New York City

Roman helmet


A gladiator's helmet shielded a warrior who fought battles staged as entertainment for the ancient Romans.

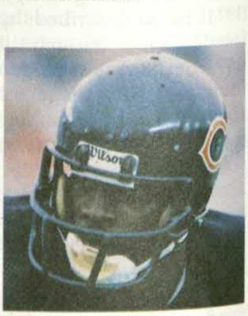
The Metropolitan Museum of Art, New York City

Chinese helmet

The Metropolitan Museum of Art, New York City

Turkish helmet

Modern combat helmet


American football helmet

Miner's helmet

Astronaut's helmet

company's world tour in 1961. He acted in many films, including *Henry V* (1944) and the ballet film *The Red Shoes* (1948).

Robert Murray Helpmann was born at Mount Gambier, in South Australia. He was knighted in 1968.

Héloïse. See **Abelard, Peter.**

Helsinki (pop. 484,471; met. area pop. 932,376) is the capital and largest city of Finland. It is also one of the nation's chief ports and the heart of its commercial and cultural life. Nearly 20 per cent of the Finnish people live in Helsinki or its suburbs. The city lies on the southern coast of the country, on the Gulf of Finland, and occupies a peninsula and several islands. For location, see **Finland** (political map).

Helsinki is a city of scenic bays and broad, treelined streets. The centre of the city's old section is Senate Square, which has many buildings designed in the neoclassical style of the 1800's. They include the Government Palace and a towering Lutheran cathedral. The main business districts of Helsinki are west of Senate Square. These newer sections of the city include buildings designed by some of the finest modern architects. Most of Helsinki's people live in apartments. Since the mid-1900's, many apartment buildings have been converted to office buildings. Large numbers of people have moved to various suburbs, which include outstanding examples of city planning.

Universities in Helsinki include the Technical University and the University of Helsinki, which is Finland's principal university. The city has many theatres, art galleries and museums. Its islands and parks have facilities for boating, skiing, swimming, and other sports.

Most of the city's people work for the government or in commerce, communications, and service occupations. Industrial employment has declined as manufacturers have moved from the city to the suburbs. However, Helsinki remains the main Finnish industrial area. Its chief products include ceramics, clothing, machinery, paper, plywood, refined sugar, and ships.

Central Helsinki has broad streets, which allow traffic to flow easily.

The main cathedral of Helsinki towers over the city's harbour. Helsinki has many beautiful buildings.

Helsinki was founded in 1550 by King Gustavus I of Sweden, which then ruled Finland. Russia and Sweden fought numerous wars in Finland from the 1500's to the 1700's, and Helsinki was twice nearly destroyed in the fighting. The city passed from Swedish to Russian rule in 1809. In 1812, Czar Alexander I made Helsinki the capital of Finland and ordered a large-scale programme of city planning and construction. Many of the impressive buildings around Senate Square were erected at that time. By 1900, Helsinki had become an industrial city with a population of more than 100,000.

Finland gained independence from Russia in 1917, and the Helsinki region's population and commercial importance have increased steadily since then.

See also **Finland** (Climate; pictures).

Helsinki Accords are several international agreements reached by the Conference on Security and Cooperation in Europe (CSCE) during the 1970's and 1980's. The first and most important of the accords pledged increased cooperation between the nations of Eastern and Western Europe. The chief agreement was signed in Helsinki, Finland, on Aug. 1, 1975, by Canada, the United States, the Soviet Union, and the 32 other members of the CSCE, almost all of which were European countries. See **Conference on Security and Cooperation in Europe.**

The official name of the chief agreement is the Final Act of the Conference on Security and Cooperation in Europe. The Final Act covered many issues. But its main goal was to reduce international tensions associated with the Cold War. The act resulted in the Western countries' finally recognizing Eastern European boundaries that had been set up after World War II ended in 1945. In addition, all signatories promised to respect human rights, including freedom of thought and religion. The signatories also agreed to increase economic and cultural cooperation, to protect the rights of journalists, and to encourage educational exchanges.

After the Final Act was signed, each side charged that the other routinely violated its provisions. For example, the Soviet Union claimed that Western governments' support for Soviet Jews who opposed certain Soviet laws violated a provision against one country's interfering in the internal affairs of another. The Western countries claimed that the same provision prohibited the Soviet invasion of Afghanistan in 1979.

The Final Act led to increased popular demand for the exercise of human rights in Eastern Europe and the Soviet Union. This demand became a major cause of the democratic revolutions that brought non-Communist governments to power in many Eastern European nations in 1989 and the early 1990's. The demand also helped bring about the Soviet Communist Party's fall from power in August 1991. These developments contributed to a sharp improvement in Western countries' relations with Eastern European nations—and with the Soviet Union before it broke up in late 1991.

Helvetia. See **Switzerland.**

Helvetians were members of a tribe that lived in what is now northwestern Switzerland. Germanic tribes threatened the Helvetians, and about 263,000 Helvetians tried to move to the Roman province of Gaul in 58 B.C. Julius Caesar's troops killed many Helvetians, and the survivors were forced to return home. Under Augustus, emperor from 27 B.C. to A.D. 14, Rome conquered all of Switzerland. The Helvetians adopted Rome's customs and its Latin language. The French-speaking people of western Switzerland sometimes refer to their area as *Helvetia.*

Hemel Hempstead is a new town in Hertfordshire, England, at the foot of the Chiltern Hills, 47 kilometres northwest of London. It is part of Dacorum local government district. The town stands near the Grand Union Canal and the M1 motorway. It has important printing and publishing industries. See also **Dacorum; Hertfordshire; New towns.**

Hemingway, Ernest (1899-1961), was one of the most well-known and influential American writers of the 1900's. He received the Nobel Prize for literature in 1954. He had won a Pulitzer Prize the previous year for his novel *The Old Man and the Sea* (1952).

Hemingway developed a plain, forceful prose style characterized by simple sentences and few adjectives or adverbs. He wrote crisp, vivid dialogue and detailed descriptions of places and things.

Hemingway also created a type of male character, sometimes called the *Hemingway hero,* who faces violence and destruction with courage. The trait of "grace under pressure"—that is, unemotional behaviour even in highly dangerous situations—is part of what became known as the *Hemingway code.*

Early life. Ernest Miller Hemingway was born in Oak Park, Illinois. After finishing school, he worked briefly as a reporter for the *Kansas City Star.* In 1918, he served as a Red Cross volunteer in Italy, driving an ambulance and working at a canteen. While there, he was seriously wounded. Hemingway's wartime experiences help explain why his writing emphasizes physical and psychological violence and the need for courage.

In 1921, Hemingway went to Paris, where he met a number of American authors, including F. Scott Fitzgerald, Ezra Pound, and Gertrude Stein. Hemingway became the principal spokesman for a group of disillusioned younger writers whom Stein named the "lost generation."

Hemingway's first published work, *Three Stories and Ten Poems,* appeared in 1923. It was followed by *In Our Time* (1924), a collection of short stories about his boyhood experiences in northern Michigan.

Rise to fame. Hemingway's most famous novels are two of his early works, *The Sun Also Rises* (1926) and *A Farewell to Arms* (1929). *The Sun Also Rises* portrays a group of Americans who, like the members of the "lost generation," were disillusioned by the war. *A Farewell to Arms,* set in Italy in World War I, is a tragic love story.

Hemingway returned to the United States in 1927. Two collections of his short stories were published during the 1930's. They contain some of his best writing, including "A Clean, Well-Lighted Place," "The Short Happy Life of Francis Macomber," and "The Snows of Kilimanjaro." He also wrote some nonfiction. *Death in the Afternoon* (1932) deals with bullfighting, which fascinated him. In *Green Hills of Africa* (1935), Hemingway described his experiences on an African safari.

In 1936, Hemingway went to Spain and covered the Spanish Civil War as a war correspondent. He used the war as the setting of *For Whom the Bell Tolls* (1940). This novel, about an idealistic American fighting the fascist forces in Spain, is one of Hemingway's finest books.

Later years. By the 1940's, Hemingway had become famous for his colourful life style and his extreme concern with presenting a tough, masculine image.

Hemingway's first published work after 1940 was *Across the River and Into the Trees* (1950). This novel reflects his growing bitterness toward life. It is largely regarded as inferior because of its sentimentality. In *The Old Man and the Sea* (1952), Hemingway revived his theme of a strong man courageously accepting fate. The hero, an old fisherman, catches a giant marlin after a long struggle—only to have the fish eaten by sharks.

Hemingway suffered physical and mental illnesses during the 1950's, and he committed suicide in 1961. *A Moveable Feast* was published in 1964, after his death. It is an autobiographical book based on notebooks he kept in Paris in the 1920's. Two novels were also published after his death—*Islands in the Stream* (1970) and the unfinished *The Garden of Eden* (1986).

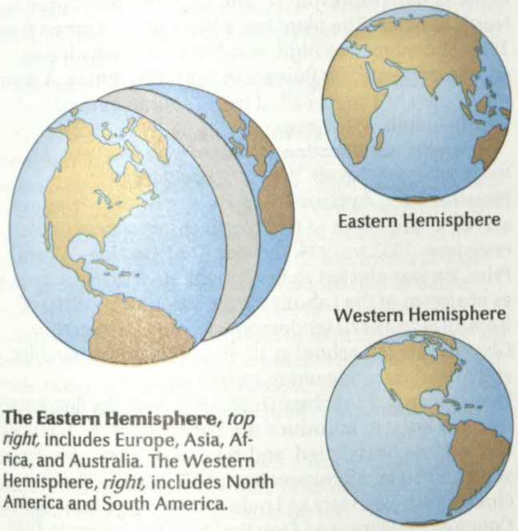
Hemiptera. See **Bug** and its list of *Related articles.*

Hemisphere is the name given to any half of the globe. It comes from the Greek word *hemisphairion,* which means *half a sphere.* The earth may be divided into six hemispheres. The Eastern Hemisphere, or Old World, includes Europe, Asia, Africa, and Australia. North America and South America make up the Western Hemisphere, or New World. Geographers have not definitely established boundaries between the Eastern and Western hemispheres. But they usually draw them along the meridians of 0° (Greenwich) and 160°.

Geographers also divide the earth into hemispheres by using the equator as a boundary line. All areas north of the equator make up the Northern Hemisphere. All areas to the south make up the Southern Hemisphere.

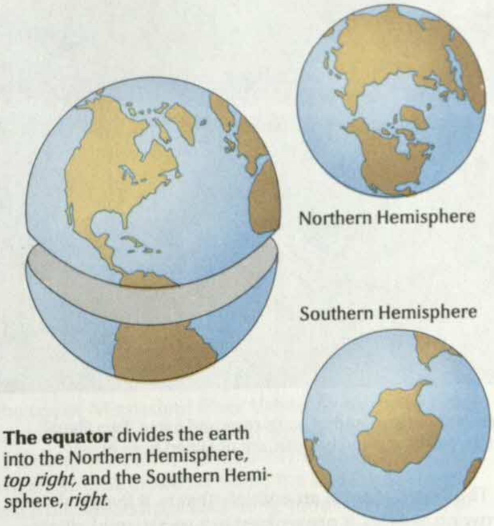
The earth may also be divided into a land hemisphere and a water hemisphere. The land hemisphere includes the half of the earth with the most land. Its centre lies near London, England. The other half of the earth, most-

Eastern and Western hemispheres



The Eastern Hemisphere, *top right,* includes Europe, Asia, Africa, and Australia. The Western Hemisphere, *right,* includes North America and South America.

Northern and Southern hemispheres



The equator divides the earth into the Northern Hemisphere, *top right,* and the Southern Hemisphere, *right.*

ly water, makes up the water hemisphere. Its centre lies near New Zealand.

Hemlock is a poisonous herb. Hemlock lives for two to several years and then flowers, produces fruit, and dies. It has many branches, purple-spotted hollow stems, and numerous clusters of small, white flowers. It grows up to 2.5 metres high. Its egg-shaped fruits are about 3 millimetres long and ripen in late summer. Its leaves look like those of parsley, for which it is often mistaken. But hemlock can be quickly recognized by its disagreeable odour that becomes quite strong when the leaves or stems are bruised. The plant is native to Europe, Asia, and some parts of Africa.

The ancient Greeks made a poisonous brew from hemlock and gave it to criminals condemned to death. The philosopher Socrates died from drinking this brew.

Scientific classification. Hemlock belongs to the parsley family, Umbelliferae (Apiaceae). It is classified as *Conium maculatum.*

Hemlock

Hemlock, also called *hemlock spruce,* is the common name of stately evergreen trees belonging to the pine family. They grow in areas of heavy rainfall in the forests of North America, Japan, China, and India.

Hemlocks have blunt, soft needles. These are joined to the twig by small woody stalks that remain on the twig when the needles fall off. These small, peglike projections are a distinctive feature.

Eastern, or *Canadian, hemlock* ranges from southern Canada to the mountains of Georgia, U.S.A. It may live up to 800 years. It is a medium-to-large tree with a dense, pyramid-shaped crown. Its short, dark-green needles grow in two rows. Each needle has two whitish bands on its lower surface. The bark of this hemlock is an important source of tannin for the leather industry. The wood is soft, and splinters easily. It is used for building frames and clapboards.

Carolina hemlock is a handsome but rare tree found high in the Appalachian Mountains from Virginia to northern Georgia. The dark green needles extend from all sides of the twig instead of appearing in two rows. *Western hemlock* is an important tree of the Pacific Northwest. It resembles the Canadian hemlock, but is larger. It can grow to a height of 60 metres with a trunk diameter of 2.5 metres. Its wood is valued both for timber and for pulp. *Mountain hemlock* is found in the mountains from Alaska to California. It grows on ridges exposed to severe weather. Some Asian species, such as the Japanese hemlock, of Japan, are planted as ornamental trees in other parts of the world. Hemlocks grow in all soils except those that are very alkaline.

Scientific classification. Hemlocks belong to the pine family, Pinaceae. The Eastern hemlock is *Tsuga canadensis.* Carolina hemlock is *T. caroliniana.* Western hemlock is *T. heterophylla,* mountain hemlock is *T. mertensiana,* and Japanese hemlock is *T. diversifolia.*

See also **Conifer; Tree.**

Hemp is a plant sometimes grown for its strong fibre. Hemp fibres are obtained from the plant's woody stem and are used to make ropes, cords, and twines. The hemp plant is native to central and western Asia, and it was once cultivated in many temperate and tropical regions throughout the world. However, the plant became less important after the development of synthetic fibres as strong or stronger than hemp fibres. The cultivation of hemp is restricted in most countries because two illegal drugs, marijuana and hashish, are obtained from hemp plants.

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The hemp plant is an *annual*—that is, it lives only one growing season. It grows best in a moist, mild climate. In regions where hemp is grown commercially, some hemp plants are raised for their seeds, and some are raised for their fibre. Both have their pollen, or *staminate,* flowers on different plants from those that produce the seed, or *pistillate,* flowers. The pollen flowers are yellowish-green and grow in large clusters. The smaller, less colourful pistillate flowers bloom later.

Fibre hemp can be sown simply by scattering the seed on the ground. Each seed grows to a single slender stem 1 to 4 metres high. Hemp thrives in soil that is well drained, fertile, and free of acidity. It is harvested when the pollen flowers have fully blossomed.

Seed hemp is planted in furrows, or drills, with earth covering them. The stalk reaches a height of 3 to 6 metres. It is thicker than the fibre-hemp stalk and has many branches.

After the long stalks are harvested, the hemp fibres must be removed. The fibres consist of many strings of long cells knitted together. They lie in the inner bark along the stem and must be separated from the bark, vegetable gums, and woody stem around them.

To free the fibres, the stalks are either soaked in soft water or hung up in the open, where they are exposed to the weather, especially to the action of dew. This process is called *retting,* or *rotting.* The water or the dew makes the matter around the fibre become rotten, so it can be removed easily. Many hemp makers in southern Europe use the water-retting method and produce the finest hemp in the world. Their fibres are fine, lustrous, soft, and creamy-white. Other hemp growers use dew retting, which produces greyish fibres. It is cheaper than water retting.

When the material around the fibres rots enough, the stalks are beaten and crushed with a heavy wooden club. The fibre is freed from the stem and cleaned roughly. The rough fibre is tied into bales and sold.

Scientific classification. Hemp belongs to the mulberry family, Moraceae. It is *Cannabis sativa.*

See also **Abacá; Jute; Rope; Sisal.**

Hen. See **Chicken.**

Henbane is a poisonous herb that is especially fatal to fowls. It is also called *black henbane.* Henbane is native to the Eastern Hemisphere, and has been introduced to North America. The plant has a bad odour. It grows from 30 to 75 centimetres high, and has sticky, hairy leaves and greenish-yellow flowers veined with purple. A drug made from henbane, called hyoscyamine, is used to dilate the pupils of the eyes.

Scientific classification. Henbane belongs to the nightshade family, Solanaceae. It is *Hyoscyamus niger.*

Henderson, Arthur (1863-1935), a British statesman, served as president of the World Disarmament Conference from 1932 to 1935. He won the 1934 Nobel Peace Prize. He was elected to Parliament in 1903, and served as chairman of the Labour Party from 1908 to 1910 and from 1914 to 1917. Henderson was born in poverty in Glasgow. He left school at 12, became an iron moulder, and joined the trade union movement.

Henderson, Fletcher (1898-1952), was the first American jazz artist to introduce the concept of the "big band" divided into brass, reed, and rhythm sections. Henderson's band was prominent from 1923 until 1938. It included such jazz stars as Louis Armstrong, Buster Bailey, Coleman Hawkins, and Don Redman. Beginning in 1935, during the "swing era," Henderson gained fame as the writer of many successful arrangements for the Benny Goodman band.

Henderson was born in Cuthbert, Georgia. He moved to New York City in 1920. He played piano for Ethel Waters and other singers, and later wrote arrangements for several bands, including those led by Isham Jones and the Dorsey brothers.

Hendon. See **Barnet.**

Hendrix, Jimi (1942-1970), was a famous American rock music guitarist. He extended the range of the electric guitar chiefly by experimenting with the electronic elements of the instrument. He manipulated switches on the guitar and pedals on the guitar amplifier to create sounds that were new to rock. Hendrix' music emphasized loud volume, a strong beat, and long solo passages that achieved great emotional impact.

James Marshall Hendrix was born in Seattle, Washington. During the early 1960's, he toured as a guitarist with many famous rhythm and blues performers. He moved to New York City in the mid-1960's and formed his own band. In late 1966, Hendrix went to England and organized a new band called the Jimi Hendrix Experience. He gained international fame with the band, and continued to perform in concerts in Europe and the United States. Hendrix died in London from complications arising from a drug overdose.

Jimi Hendrix

Henequen, also spelt *henequin* or *heniquen,* is a yellow fibre made from the leaves of the henequen plant. The plant is native to the Yucatán Peninsula in Mexico and is related to the century plant. Its shiny-tipped leaves grow from a trunk and are sometimes 2.3 metres long and 10 centimetres wide. Bundles of tough fibres run through the leaves. Machines separate the henequen fibres from the softer portions. The fibres are then dried. Henequen fibres are rough and stiff and are used to make twine.

Scientific classification. The henequen plant belongs to the agave family, Agavaceae. It is classified as *Agave fourcroydes.*

See also **Sisal; Yucatán Peninsula.**

Hengest and Horsa, according to Bede and the *Anglo-Saxon Chronicle,* were two Jutish leaders invited to England by a local king named Vortigern to help to repel invaders from northern Britain. They settled in southeastern England in about A.D. 449. In about 455, they turned on Vortigern and defeated him in battle, possibly at Aylesford, in Kent. Horsa was killed, and Hengest established a kingdom in Kent. Some historians believe that Bede and the *Chronicle* were repeating legends. *Hengest* is also spelt *Hengist.* See **Anglo-Saxon Chronicle; Bede; Kings and Queens of Britain and Ireland.**

Henie, Sonja (1912-1969), was a Norwegian figure skater who won three Olympic titles and transformed the sport into a display of ballet on ice.

Born in Oslo, Miss Henie competed in the 1924 Olympics as an 11 year-old. She became Olympic champion in Holland (1928), the United States (1932) and Germany (1936). She won ten consecutive world championships between 1927 and 1936, and the European title every year from 1931 to 1936.

Miss Henie's flamboyant jumps and spins, and fashions, established lasting standards. In 1936, she appeared in the first full-length film about ice skating, *One in a Million,* and became a United States citizen in 1941.

Sonja Henie died of leukaemia during a flight to Oslo for treatment.

Henley, William Ernest (1849-1903), was an English poet, editor, and critic. He wrote his works in spite of suffering from tuberculosis. The illness caused doctors to amputate a foot, and forced Henley to spend 20 months in hospital. He wrote *Book of Verses* (1888) and the popular, optimistic poem "Invictus." His other works include *Views and Reviews* (1890), *The Song of the Sword* (1892), *London Voluntaries* (1893), and *A Song of Speed* (1903). He was born in Gloucester, Gloucestershire.

Henley-on-Thames is a town on the River Thames in South Oxfordshire local government district. It is famous for the rowing regatta held there each July. The church is built in the Decorated and Perpendicular styles. See **South Oxfordshire.**

Henna is an orange-red dye that varies in colour with the article on which it is used. It comes from the leaves of a small shrub that grows in Arabia, Iran, the East Indies, and North Africa. The henna plant is also raised for its fragrant blossoms which are used to make a fragnant oil. Women in Asia use henna to colour their nails, fingertips, and parts of their feet. It has been used to dye men's beards, as well as the manes and hoofs of horses. People have also coloured wool, silk, and animal skins with henna. Mummies of Ancient Egypt were found wrapped in henna-dyed cloth. Henna is used today mainly as a hair dye.

Scientific classification. Henna is in the loosestrife family, Lythraceae. It is *Lawsonia inermis.*

Hennepin, Louis (1626?-1705?), was a Belgian missionary and explorer who became famous for his journey to the Mississippi River Valley in North America. He accompanied the French explorer Sieur de La Salle across the Great Lakes and then explored the upper part of the Mississippi River.

Hennepin was born in Ath, in what is now Belgium. He joined the Franciscans, a Roman Catholic order. In 1675, King Louis XIV of France sent him to what is now Canada, where France had established a colony. In 1676, Hennepin went to Fort Frontenac, on the site of the present city of Kingston, Ontario, Canada. There, he founded a mission among Iroquois Indians.

In 1679, Hennepin set out with La Salle's expedition near Niagara Falls. The explorers crossed Lakes Erie, Huron, and Michigan in the *Griffon,* the first ship to sail these waters.

Early in 1680, Hennepin and two associates explored the upper Mississippi River Valley. Sioux Indians captured them and held them for several months.

During the 1690's, Hennepin wrote two books in which he took credit for being the first European to track the Mississippi River to its mouth at the Gulf of Mexico. He said he reached the gulf before being captured by the Indians. But historians credit La Salle as the first to track the river to the gulf.

Henry was the name of eight kings of England.

Henry I (1068-1135) was the youngest son of William the Conqueror and third of the Norman line of kings. He succeeded his brother, William II, in 1100. Henry helped to unite the Saxons and Normans in England. To gain the favour of the Saxons, Henry married Matilda, daughter of Malcolm III of Scotland and his Saxon wife Margaret.

During his reign, Henry worked to restrain the growing power of the barons. He promoted the Norman system of centralized rule and gave the royal courts greater authority. His wars against rebellious nobles in France helped start a feeling of English nationalism.

See **William** (I) of England.

Henry II (1133-1189) was the son of Geoffrey Plantagenet, Count of Anjou, and a grandson of Henry I. He became king in 1154, the first English ruler of the Plantagenet family (see **Plantagenet**). At the height of his power, Henry ruled England and almost all western France. His marriage to Eleanor of Aquitaine, the most famous woman of the age, brought the duchy of Aquitaine under his control (see **Eleanor of Aquitaine**). Henry also claimed to rule Scotland, Wales, and eastern Ireland.

Henry II tried to make the Roman Catholic Church in England submit to his authority. This policy brought him into conflict with Thomas à Becket, Archbishop of Canterbury (see **Becket, Saint Thomas à**).

Henry made Anglo-Saxon common law, rather than the revised Roman law, the supreme law of the land in England (see **Common law**). In addition, Henry introduced trial by jury and circuit courts. In his later years, Henry's sons often rebelled against him.

Henry III (1207-1272) was the eldest son of King John, and a grandson of Henry II. He came to the throne in 1216, but did not rule until he came of age in 1227.

Henry was a fickle tyrant who surrounded himself with favourites from other countries. The English nobles revolted against his rule and the foreign influences in his court. They forced Henry to grant the Provisions of

Oxford, which transferred governing powers to a committee of barons. Later, Henry broke the agreement and raised an army. However, he was defeated and captured at the battle of Lewes in 1264. Simon de Montfort, leader of the reform party, then governed England until 1265 (see **Montfort, Simon de**). Edward ruled the country during the rest of Henry's lifetime (see **Edward** [I] of England).

Henry IV (1367-1413), son of John of Gaunt, Duke of Lancaster, was the first king of the House of Lancaster (see **John of Gaunt; Lancaster**). He was often called Henry of Bolingbroke. He defeated his cousin, King Richard II, in 1399, and parliament elected him king. Henry admitted that parliament had the right to choose the king. This admission formed an important increase in parliamentary power.

Revolts and conspiracies marred Henry's reign, but he put them down with great effort. He encouraged towns to develop, and helped England's growing trade. However, he was intolerant of religious differences, and persecuted the Lollards (see **Lollards**).

Henry V (1387-1422), the eldest son of Henry IV, was crowned in 1413. Henry V followed his father's policy toward the Lollards. Many of them were put to death.

Henry renewed the Hundred Years' War with France, which had begun during the reign of Edward III. He was determined to make good Edward's old claim to the French throne. In 1415, Henry won one of the most famous victories in English history. His small army crushed a host of French lords and knights at Agincourt (see **Agincourt, Battle of**). Five years later, Henry married the daughter of Charles VI, King of France. By the Treaty of Troyes, Henry forced Charles to declare him heir to the French crown. When Henry died two years later, he had won the entire northern half of France. He appears as Prince Hal in Shakespeare's *Henry IV,* Part I and Part II.

Henry VI (1421-1471) was the last English king belonging to the House of Lancaster. He held the thrones of both England and France when he was less than a year old. Henry VI was heir to both his father, Henry V, and to Charles VI of France, who died within two months of each other.

Henry VI was pious and gentle, but he was a weak ruler, and had occasional attacks of insanity. The English nobles took advantage of his weakness to misgovern the kingdom in their own selfish interests. In France, the great conquests of Henry V were gradually lost. By 1453, the French had retaken all their land except the port of Calais (see **Joan of Arc, Saint; Hundred Years' War**). In 1450, a popular uprising, known as Jack Cade's rebellion, shook England, and the supporters of the House of York challenged King Henry and the House of Lancaster (see **York**).

In 1461, the Yorkists drove Henry from the throne, and made Edward IV king. Henry ruled again briefly in 1470 and 1471, but Edward defeated his forces at the battles of Barnet and Tewkesbury. Henry was imprisoned in the Tower of London, where he died. See **Wars of the Roses.**

Henry VII (1457-1509), the first king of the House of Tudor, came to the throne in 1485 as a descendant of the House of Lancaster. He had killed Richard III at Bosworth Field, which was the last battle of the Wars of the Roses. To strengthen his claim to the English throne, Henry married Elizabeth, daughter of Edward IV, uniting the houses of Lancaster and York.

Henry was tough, cold, shrewd, and sly. He kept the nobles in fear by increasing the political power of the wealthy middle classes, and he taxed the common people heavily. He eliminated pretenders to the throne, and managed to survive several revolts and conspiracies. See **Warbeck, Perkin.**

Henry VII increased England's influence in European affairs by making important alliances. He arranged a marriage between his son Arthur and Catherine of Aragon, daughter of Ferdinand and Isabella of Spain. After Arthur died, the king succeeded in securing the young widow, and her dowry, for his younger son, Henry. He also negotiated a marriage between his daughter Margaret and James IV of Scotland. He kept England out of European wars, however, and by severe economy accumulated an immense fortune.

During Henry VII's reign, England first turned its eyes toward America. In 1497, Henry sent John and Sebastian Cabot to explore North America (see **Cabot**). See **Tudor, House of.**

Henry VIII (1491-1547) separated the Church of England from the Roman Catholic Church and established the Reformation in England. He helped England become one of the world's greatest naval powers, but spent his father's fortune on foreign wars. Henry is also famous for his six wives. His private life greatly influenced English political history. He was sometimes autocratic and sometimes cruel. But he understood his people and knew how to hold their confidence.

When Henry came to the throne in 1509, his first act was to marry his brother's widow, Catherine of Aragon. Catherine bore five children, but only one lived—Mary, who later became queen (see **Mary** [I]). Henry wanted a son. He turned his attentions to a maid of honour at court, Anne Boleyn. Thomas Cardinal Wolsey, Henry's able and ambitious chief minister, asked Pope Clement VII to annul the king's marriage. He argued that it was wrong for Henry to have married his brother's widow. But the pope refused, and Henry dismissed Wolsey in 1529 (see **Wolsey, Thomas Cardinal**).

The king was determined to have his divorce. He denied that the pope had authority over England, and secretly married Anne Boleyn early in 1533. Henry's choice for Archbishop of Canterbury, Thomas Cranmer, declared the marriage of Henry and Catherine null and void (see **Catherine of Aragon**). Anne was then crowned queen.

At Henry's insistence, parliament passed two acts in 1534 that made the break with the Roman Catholic Church complete. One declared that the pope had no authority in England. The other, the Act of Supremacy, made the Church of England a separate institution, and it also established the king as its supreme head. The two acts officially established the Reformation in England (see **Reformation**).

Anne bore Henry a second daughter, Elizabeth (see **Elizabeth I**). Then in 1536, the king had his wife beheaded on a charge of infidelity (see **Boleyn, Anne**). Henry's third wife, Jane Seymour, died shortly after the birth of a son (see **Edward** [VI]).

At the urging of his chief minister, Thomas Cromwell, Henry married a German princess, Anne of Cleves. But Cromwell was disgraced and executed, and Henry divorced Anne. The king later married Catherine Howard, who, in 1542, was convicted of misconduct and executed. Henry's sixth and last wife, Catherine Parr (1512-1548), outlived him.

See also England (History); **Kings and Queens of Britain and Ireland; Shakespeare, William** (Shakespeare's plays); **Cranmer, Thomas.**

Henry was the name of four French kings.

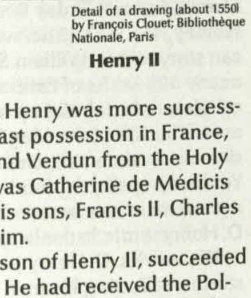
Henry I (1008?-1060) was the grandson of Hugh Capet, founder of the Capetian dynasty. During his reign, feudal power in France reached its height (see **Capetian dynasty**).

Henry II (1519-1559) succeeded his father, Francis I, in 1547. He was ambitious and persistent, but he differed from his father in most respects (see **Francis** [I] of France). He tormented Huguenots (French Protestants) and took their lands. These actions helped start the destructive French religious wars (see **Huguenots**). Henry contested Spain's dominance over Italy but never could defeat the Spaniards. In 1559, he signed the Treaty of Cateau-Cambrésis, which formally recognized Spanish control in Italy. Elsewhere, Henry was more successful. He took Calais, England's last possession in France, and the cities of Metz, Toul, and Verdun from the Holy Roman Empire. Henry's wife was Catherine de Médicis (see **Catherine de Médicis**). His sons, Francis II, Charles IX, and Henry III, succeeded him.

Detail of a drawing (about 1550) by François Clouet; Bibliothèque Nationale, Paris

Henry II

Henry III (1551-1589), third son of Henry II, succeeded his brother Charles IX in 1574. He had received the Polish crown earlier the same year, but he left Poland when he heard of Charles' death. Henry was a weakling who divided his time between scheming and immorality. His mother, Catherine de Médicis, held great authority during the earlier part of his reign. Then influence passed to his favourites among the young nobles. Finally, a contest for power took place between two strong rival leaders, the Roman Catholic Henry, Duke of Guise, and the Protestant Henry of Navarre. The contest continued throughout the reign. Alarmed at concessions that were made to the Huguenots, the Catholics organized the Catholic League. This led to open war. In the War of the Three Henrys, the real contest was between Henry of Guise and Henry of Navarre. Henry III was jealous of the Duke of Guise, and arranged the duke's assassination. He then had to flee to Navarre for protection. Henry III was the last Valois king of France (see **Valois**).



Detail of a drawing (about 1588) by François Quesnel; Bibliothèque Nationale, Paris

Henry III

Henry IV (1553-1610), who succeeded Henry III in 1589, was Henry of Navarre, the Protestant leader in the War of the Three Henrys. He was the first Bourbon king, and was a man of courage, vigour, and intelligence (see **Bourbon**). Religious conflict continued after the death of Henry III, and Henry IV realized that he could restore peace only if he himself became Catholic. In 1593, he was accepted into the Catholic Church. This brought recognition of his right to the kingship, and French cities welcomed him on his triumphal march to Paris.

Another of Henry's great successes was victory over Spain. Spain had repeatedly interfered in French affairs, plotting with rivals for the French throne and supporting the Catholic League. Henry decided to stop this interference, and joined the English and Dutch in their war against King Philip II. The Spanish ruler yielded and recognized Henry as king of France.

Detail of a painting (1610) by Frans Pourbus the Younger; the Louvre, Paris (Clichés des Musées Nationaux, Paris)

Henry IV

In 1598, Henry issued the Edict of Nantes, which granted considerable rights and privileges to the Huguenots (see **Nantes, Edict of**). The edict made remarkable concessions to the Huguenot minority in a country as strongly Catholic as France. Before he was murdered, Henry also reformed France's finances, strengthened its agriculture and commerce, and worked to maintain a balance of power in Europe that helped protect France.

See also **France** (History); **Huguenots.**

Henry was the name of seven German rulers. All except Henry I were elected emperors of the Holy Roman Empire (see **Holy Roman Empire**).

Henry I (876?-936), called the Fowler, and **Henry II** (973-1024) were of the Saxon dynasty.

Henry III (1017-1056), of the Salian dynasty, became king of Germany in 1039. He was crowned emperor in 1046. Henry enforced German authority throughout the territories of the Holy Roman Empire. He supported reforms in the Roman Catholic Church by denouncing the marriages of priests and the buying of church offices. In 1046, he invaded Italy and had his own candidate for the papal throne recognized over three rivals. Later, he claimed control of nominations for pope.

Henry IV (1050-1106), son and successor of Henry III, became king of Germany at the age of six. The nobles revolted while his mother served as regent. When he took control of the kingdom in 1069, he tried to establish his authority throughout Germany. But he came into conflict with Pope Gregory VII. In 1075, Gregory denied civil rulers the authority to make appointments to church offices. In response, Henry called a council that met at Worms in 1076 and declared the pope deposed. Gregory in turn expelled Henry from the church and released his subjects from allegiance to him.

Many German princes supported the pope, and so

Henry had to yield. Pope Gregory had retired to a stronghold at Canossa in the Apennines. It is said that Henry had to stand barefoot in the snow for three days before he was permitted to kneel at the pope's feet and be pardoned. But after his return to Germany, Henry renewed the struggle. For years his country was torn by civil war. In 1080, Gregory again excommunicated Henry and deposed him. Henry later captured Rome, and in 1084 he replaced Gregory with a pope of his own choice. Gregory died in exile soon afterward, but his successors took up the contest. One of them again expelled Henry from the church. Finally, in 1105, Henry was forced to abdicate after one of his sons had been persuaded to rebel against him. Henry died while preparing for war. His son, **Henry V** (1081-1125), succeeded him and ruled Germany from 1106 to 1125.

Henry VI (1165-1197), a member of the Hohenstaufen family, succeeded his father, Frederick Barbarossa, in 1190 (see **Hohenstaufen**). His marriage to Constance of Sicily gave him a claim to her kingdom. He also collected a large ransom from King Richard the Lion-Hearted of England, who was a prisoner of the Duke of Austria. Henry strengthened his position in Italy through the aged Pope Celestine III. He also laid plans to keep the imperial throne in the Hohenstaufen family and to take Jerusalem as the start of a new crusade. But these projects ended when Henry died at the age of 32.

Henry VII (1269-1313) was a member of the Luxembourg dynasty. Henry was emperor of the Holy Roman Empire from 1308 to 1313.

Henry, of Portugal. See **Henry the Navigator.**

Henry is the unit used to measure *inductance,* the reaction of an electric current against the magnetic field that surrounds it. If the flow of current in a circuit changes or alternates, the magnetic field around the circuit also changes. This changing magnetic field *induces* (creates) a voltage in the circuit that opposes any additional increase or decrease in the flow of current. A circuit has 1 henry of inductance if a current change of 1 ampere per second induces an opposing voltage of 1 volt. The henry was named after the American physicist Joseph Henry. Its symbol is H. See also **Inductance.**

Henry, Duke of Guise. See **Henry** (III, of France).

Henry, John, a black labourer, is a hero in American folklore. He is the subject of perhaps the most well-known American folk ballad and of many stories and songs.

The original story about John Henry is based on an actual event involving a man of that name. In the early 1870's, labourers were building the Big Bend Tunnel on the Chesapeake and Ohio Railroad in West Virginia. They used long-handled hammers to pound a steel drill into rock when making holes to hold blasting explosives. One day, a man brought an experimental steam drill to the site. He claimed it could dig a hole faster than 20 workers using hammers.

According to the ballad, John Henry raced the steam drill to prove that a man could dig a hole faster than a machine:

> They placed John Henry on the right-hand side,
> The steam drill on the left;
> He said, "Before I let that steam drill beat me down
> I'll die with my hammer in my hand, O Lord,
> And send my soul to rest."

In the ballad, John Henry won the race but died from exhaustion at the moment of his victory. The real John Henry, after beating the steam drill in the race, is said to have been crushed by rock that fell from the ceiling of the tunnel.

The legend of John Henry developed from ballads, songs, and stories about him. He symbolized the workers' fight against being replaced by machines. The earliest known written version of the ballad appeared about 1900.

Henry, Joseph (1797-1878), an American physicist, became famous for his discoveries in electromagnetism. He anticipated both Samuel F. B. Morse's invention of the telegraph and Michael Faraday's discovery of electromagnetic induction. Henry received no credit for his work at the time, but the unit of electrical inductance is now called the *henry* (see **Henry**).

Henry was born in Albany, New York. He was educated at Albany Academy, where he later taught mathematics and physics. He began experimenting in electromagnetism while teaching there. His first major work was improving the electromagnet, which William Sturgeon had discovered. From 1832 to 1846, Henry was a professor at Princeton University. He later became the first secretary and director of the Smithsonian Institution. In 1867, he became president of the National Academy of Sciences, which was established in 1863.

See also **Electromagnetism; Faraday, Michael; Morse, Samuel Finley Breese.**

Henry, O. (1862-1910), was the pen name of an American story writer, William Sydney Porter. Most of his nearly 300 works of fiction show a mastery of mechanical plots, which build up to sharp, unexpected endings, as in "The Gift of the Magi" (1905). Most of O. Henry's stories are sentimental rather than psychologically deep. Yet his sympathy for human weaknesses and the naturalness of his characters make his stories appealing. O. Henry wrote in the language of the common people.

His works. O. Henry published about 16 volumes of stories, reflecting his own colourful experiences and those of his associates. The models of some of his best-known characters were criminals and soldiers of fortune, whom he met in Central America and later in New York. His stories usually tell about victims of coincidence or fate. An example is "The Furnished Room" (1904). In this story, a lover seeks his sweetheart, who came to New York for a singing career. He rents a room where he commits suicide after being unable to find the girl. The lover never learns that his sweetheart had earlier killed herself in that same room. *The Voice of the City* (1908) deals with the loneliness and tragic predicaments of innocent country folk who come to the impersonal city to seek their fortune.

O. Henry's other works include *Cabbages and Kings* (1904), *The Four Million* (1906), *The Trimmed Lamp* (1907), *Heart of the West* (1907), *The Gentle Grafter* (1908), *Roads of Destiny* and *Options* (1909), *Strictly Business* and *Whirligigs* (1910), *Sixes and Sevens* (1911), and *Waifs and Strays* (1917). *The Complete Works of O. Henry* was published in 14 volumes in 1917.

His life. William Sydney Porter was born in Greensboro, North Carolina, on Sept. 11, 1862. He left school when he was 16 and worked in his uncle's pharmacy. Then he went to Texas and worked for two years on a ranch. Later he moved to Austin, Texas, where he was a bank clerk for a while. He began to write short sketches, some of which appeared in the Detroit *Free Press.* In 1894, he bought a paper called the *Iconoclast,* and renamed it *The Rolling Stone.* A year later, he moved to Houston, Texas, where he wrote for a newspaper.

In 1896, Porter was called back to Austin to stand trial on a charge of stealing funds from the bank. Although he might have been pardoned, he fled to Honduras. When he returned to Austin to the deathbed of his wife, he was arrested and imprisoned for three years. Using various pen names, he wrote and published several short stories while he was in prison. After he was released, he went to New York City, where he worked first as a newspaper columnist and then a short-story writer.

See also **Short story.**

Henry, Patrick (1736-1799), was a distinguished American statesman, lawyer, and orator at the time of the American Revolution. He is remembered most for the words, "Give me liberty or give me death," which he spoke in 1775, urging that the Virginia militia be armed for defence of the colony against England. He served as the governor of Virginia during the Revolutionary War.

Early life. Henry was born in Hanover County, Virginia. He attended school for only a short time, but was taught by his father. He then studied law and received his licence to practise in 1760.

In 1764, Henry was elected to the Virginia House of Burgesses. His speech against the Stamp Act in 1765 is one of his greatest orations (see **Stamp Act**). In it, according to tradition, appear the often-quoted words: "Caesar had his Brutus—Charles the First, his Cromwell—and George the Third—*may profit by their example.* If *this* be treason, make the most of it."

In August 1774, the colony of Virginia elected Henry a delegate to the First Continental Congress (see **Continental Congress**). Later, he was chosen as a member of the committee to draw up the first constitution of the commonwealth of Virginia.

Detail of *Patrick Henry Before the Virginia House of Burgesses* (1851), an oil painting on canvas by Peter Frederick Rothermel

Patrick Henry lashed out at English tyranny in a great speech before the Virginia House of Burgesses in 1765.

Career as governor. Henry became governor of the new commonwealth of Virginia as soon as it was established in 1776. He moved into the palace at Williamsburg, where the English colonial governors had lived. He was a hard-working administrator. Henry showed his feeling for democracy when he became the first American politician to refer to the voters as "fellow citizens."

The Revolutionary War brought many problems to Virginia, and Henry worked hard to solve them. He encouraged the mining of lead to provide ammunition, and imported and manufactured gunpowder. He set up shipyards and dockyards to protect the Virginia coast, and he arranged for loans.

Henry was criticized in spite of his hard work, especially when the forces under the British General Banastre Tarleton overran Virginia. But he was elected governor again in 1777, 1778, 1784, and 1785. During his second term, Henry provided supplies for the George Rogers Clark expedition, which conquered the Northwest Territory (see **Northwest Territory**).

In 1788, Henry served in the Virginia state convention, that was called to ratify the United States Constitution. He opposed ratification because he believed that the Constitution endangered the rights of individuals and states. After he was defeated, however, he accepted the Constitution and joined the Federalist Party. Henry was largely responsible for the first 10 amendments to the Constitution, known as the Bill of Rights (see **Bill of rights**).

Return to private life. Public service left Henry badly in debt, and in 1788 he returned to his law practice. His fame as a brilliant speaker gained him many clients, and he soon became a successful criminal lawyer. His law fees helped him to buy land, and in 1794, he retired to his Red Hill estate, near Appomattox, Virginia.

During the next five years, Henry refused many requests to return to public life. Finally George Washington persuaded him to become a candidate for representative in the Virginia state legislature. Henry made his last great speech during this campaign. The speech was a denial of a state's right to decide the constitutionality of federal laws. Henry told the voters: "United we stand, divided we fall. Let us not split into factions which must destroy that union upon which our existence hangs." Henry won the election, but he died before he could take office.

Henry of Navarre. See **Henry** (IV, of France).

Henry the Navigator (1394-1460) was a Portuguese prince who promoted explorations of the west African coast during the 1400's. These explorations helped advance the study of geography and made Portugal a leader in navigation among European nations of that time. Henry sent out more than 50 expeditions but went on none of these voyages himself.

Henry was the son of King John I and Queen Philippa. He was a serious, studious youth with a special interest in mathematics and astronomy. Henry and two older brothers, Duarte and Pedro, wanted to prove they were worthy to be knighted. With their father's approval, they organized an army and captured Ceuta, an important commercial town in Morocco. The brothers were knighted, and Henry was made governor of Ceuta.

The commercial routes between Ceuta and inner Africa stirred Henry's interest in the geography of Africa.

Henry wanted to expand Portugal's trade and influence along the African coast. He also hoped to find the source of the gold that Islamic traders had been carrying north from central Africa for hundreds of years. Henry's skill in mathematics and astronomy helped him organize expeditions along the northwest African coast. In 1419, two Portuguese explorers sent by Henry reached Porto Santo, one of the Madeira Islands. These explorers, João Gonçalves and Tristão Vaz, sailed to the island of Madeira itself in the early 1420's. Portugal colonized both islands.

One of Henry's goals was to send explorers beyond Cape Bojador, in what is now Western Sahara. The cape was the southernmost point known to Europeans at that time. After several unsuccessful attempts, an expedition led by Gil Eanes finally passed the cape in 1434. Eanes reached Rio de Oro, also in Western Sahara, in 1436.

One of Henry's explorers, Antão Gonçalves, returned to Portugal with some Africans he had captured on an expedition in 1441. These people were the first slaves brought from west Africa to Europe. One of the captives was a chieftain named Adahu, who told Henry about lands farther south and inland. In 1441, Nuño Tristão sailed as far south as Cape Blanc, on the border of Western Sahara and Mauritania. Diniz Diaz reached Cape Verde, in present-day Senegal, in 1445. By the time of Henry's death in 1460, Portuguese ships had reached the coast of Sierra Leone.

Henry planned and raised the money for the expeditions. He was aided by mapmakers, astronomers, and mathematicians of many nationalities, whom he gathered together at Sagres, near Cape St. Vincent, Portugal. The navigational knowledge gained under Henry's direction led to several historic voyages within 50 years after his death. They included the voyages of the Portuguese explorers Vasco da Gama and Bartolomeu Dias around the southern tip of Africa.

Henson, Matthew Alexander (1867-1955), was the only American who accompanied Robert E. Peary on the last leg of the explorer's journey to the North Pole in 1909. Henson was born on a farm in Maryland. Henson travelled on various expeditions with Peary for more than 20 years as personal assistant and dog driver.

Henson received many honours for his part in the 1908-1909 expedition. He wrote the book *A Negro Explorer at the North Pole.* His biography, *Dark Companion,* written by Bradley Robinson, was published in 1947.

Matthew A. Henson

Henty was the name of a pioneering family in Australia. During the late 1820's and early 1830's, the Hentys emigrated from West Tarring, in southeastern England. They are generally regarded as the first Europeans to settle in what is now Victoria. But descendants claim that the Mills brothers settled at Port Fairy before the Hentys settled at Portland.

The Henty family consisted of Thomas Henty (1775-1839), his wife, seven sons, and one daughter. His children were James (1800-1882), Jane (1805-1893), Charles (1807-1864), William (1808-1881), Edward (1810-1878), Stephen George (1811-1872), John (1813-1868), and Francis (1815-1889).

In 1829, James, Stephen, and John emigrated to Western Australia. Later, they moved to Van Diemen's Land (now Tasmania). In the meantime, Thomas Henty had settled on the island with the rest of his family. In 1834, he sent his fourth son, Edward, to explore the southern coast of the Australian mainland in search of good farming land. Edward began farming at Portland Bay and became the founder of Victoria's wool industry. Later, the rest of the family joined him. The Hentys prospered. James, William, Edward, and Stephen became members of legislative councils in the colonies. William served as colonial secretary in Tasmania from 1857 to 1863. James founded a business in Melbourne.

Henty, G. A. (1832-1902), wrote lively and popular adventure books for boys. His 80 books, written in a direct style, include *The Young Franc-Tireurs, Facing Death, With Clive in India,* and *The Bravest of the Brave.* Henty was born at Trumpington, in Cambridgeshire, England. His full name was George Alfred Henty. He attended Cambridge University, but left in 1855 to volunteer for the ambulance service in the Crimean War.

Henze, Hans Werner (1926-   ), is a German composer. His works incorporate modern atonality with more traditional musical forms. Often dissonant and angular, Henze's music is also considered highly expressive and colourful. Henze's radical political views, as well as his bold musical ideas, have made him controversial.

Henze's most famous works are operas. They include *Boulevard Solitude* (1952), *Elegy for Young Lovers* (1961), and *Der Junge Lord (The Young Lord,* 1965). Henze is also known for his music for ballets. In addition, he has written piano concertos, symphonies, choral works, chamber music, and several theatre pieces with revolutionary political themes. The latter include *El Cimarrón* (1970) and *La Cubana* (1973). Henze's essays have been collected in *Music and Politics* (1982).

Henze was born in Gütersloh. His early works show the influence of the composers Arnold Schoenberg and Igor Stravinsky.

Hepatica is a sturdy but dainty woodland plant that grows in almost all countries of the Northern Hemisphere. It is related to the anemone. The name *hepatica* comes from a Greek word that means *liver.* The hepatica's dark green, leathery leaves have three scallops, or *lobes,* and are shaped somewhat like livers. For this reason, the plant is often called *liverwort.* Six petallike sepals form the plant's buttercup-shaped blossoms. Each year, the blossoms appear before the new green leaves do. The *common hepatica* of Europe, Asia and North America grows from 10 to 15 centimetres high. The flowers may be a lavender-blue, white or red. There is also an attractive double flowered form.

Hepaticas are generally grown in rock gardens in a cool, shaded situation. The soil should be enriched with lime and peat.

Scientific classification. Hepaticas belong to the buttercup family, Ranunculaceae. The common hepatica is *Hepatica triloba.*

Hepatitis is a disease characterized by inflammation of the liver. Its symptoms include weakness, loss of appetite, nausea, vomiting, and *jaundice,* a yellowish discoloration of the skin and tissues. There are two major types of hepatitis, *viral* and *toxic.*

Viral hepatitis. Scientists have identified three main forms of viral hepatitis. These forms are: (1) hepatitis A, or infectious hepatitis; (2) hepatitis B, or serum hepatitis; and (3) hepatitis C (formerly designated non-A, non-B hepatitis). Hepatitis also may result from other viral infections or from a combination of two different viruses.

Most cases of hepatitis A result from eating contaminated food or drinking contaminated water. Symptoms of the disease appear about four weeks later. Most cases of hepatitis A last from two to six weeks. The symptoms may be lessened—or even prevented—if injections of gamma globulin are administered within a week after the patient has been exposed to the virus (see **Gamma globulin**).

The virus of hepatitis B was once most commonly transmitted through the transfusion of contaminated blood. Since the 1970's, tests that detect the virus in blood donations have largely eliminated transmission through blood transfusions. Today, hepatitis B is spread mainly by the use of improperly sterilized medical instruments, by hypodermic needles shared by drug abusers, and through sexual contact with infected people. During the 1980's, vaccines that protect against hepatitis B became available.

Symptoms of hepatitis B appear from 6 to 12 weeks after infection, and many patients do not know they have the disease until jaundice occurs. People who have had hepatitis B may carry the virus in their blood for years after recovery. Such carriers can spread the hepatitis B virus. In addition, a pregnant woman who is carrying the virus may transmit the disease to her fetus. Carriers have a moderate risk of developing cirrhosis of the liver and occasionally may develop liver cancer. About 1 per cent of all hepatitis B cases end in death. Pregnant women should be screened for the virus.

In 1977, scientists discovered a new hepatitis virus. This virus, called the *delta agent,* cannot cause infection by itself. It is infectious only when it combines with the hepatitis B virus. Together, these viruses cause an acute form of hepatitis known as *delta hepatitis.* People immune to hepatitis B are also immune to delta hepatitis.

The blood-borne virus responsible for what formerly was called non-A, non-B hepatitis was isolated in the late 1980s. Named hepatitis C virus, it accounts for thousands of cases of post-transfusion hepatitis each year. In 1988, researchers announced the discovery of a virus they believe is responsible for most cases of transfusion-caused hepatitis. However, the illness also occurs in many people who have not received a blood transfusion. Scientists do not know how the disease is transmitted in such patients. However, experience shows that half of all those infected go on to develop the chronic form of the disease. Of these, 20 per cent may have cirrhosis of the liver. Tests are being developed to identify carriers of the hepatitis C virus so as to safeguard blood transfusions.

Toxic hepatitis results from exposure to alcohol, a variety of medications, and certain chemicals, including carbon tetrachloride. Such chemicals can enter the body by being swallowed, inhaled, absorbed through the skin, or received in injections. The development and treatment of toxic hepatitis varies, depending on the substance that causes it.

See also **Liver** (Hepatitis).

Hepburn, Katharine (1909-   ), is an American actress. She has been nominated for 12 Academy Awards—more than any other performer. She won awards for best actress in *Morning Glory* (1933), *Guess Who's Coming to Dinner* (1967), *The Lion in Winter* (1968), and *On Golden Pond* (1981). She became famous for her distinctive voice and manner.

Hepburn was born in Hartford, Connecticut, U.S.A. She made her film debut in 1932 in the melodrama *A Bill of Divorcement.* Her performances include comic portrayals in *Adam's Rib* (1949) and *Pat and Mike* (1952)—both co-starring Spencer Tracy—and *The African Queen* (1951). She played serious dramatic roles in *Little Women* (1933), *Summertime* (1955), *The Rainmaker* (1956), and *Long Day's Journey into Night* (1962). Hepburn has made about 40 films and has also appeared on the stage in a number of comedies and Shakespearean roles. She also starred in the musical *Coco* (1969).

Katharine Hepburn

Hephaestus was the Greek god of fire and the forge. He was the blacksmith of the gods and the patron of metalworkers. Hephaestus resembled the Roman god Vulcan in many ways.

Most Greek gods became known for their beauty, but Hephaestus was lame and deformed. Greek artists showed him as a powerful, bearded workman wearing a short tunic and a cone-shaped hat and holding a hammer and tongs. Hephaestus created many masterpieces in metal, including the armour of the warrior Achilles and the golden throne of Zeus, the king of the gods. The marriage of Hephaestus and Aphrodite, the goddess of love, symbolized the union of art and beauty.

The Greeks associated Hephaestus with volcanic regions. In early times, Hephaestus was worshipped on the volcanic island of Límnos (also spelled Lemnos).

See also **Vulcan; Pandora; Zeus.**

Hepplewhite, George (? -1786), was an English furniture maker and designer. No documented examples of his furniture survive. Hepplewhite's reputation rests on his book of furniture designs, *The Cabinet-Maker and Upholsterer's Guide* (published in 1788, after his death). The *Guide* contains engravings of nearly 300 designs that Hepplewhite and other English furniture designers made popular between about 1770 and 1790. Furniture made according to these designs is known as Hepplewhite.

Hepplewhite furniture has graceful contours and features delicate ornamentation with painted *mouldings* (wooden strips) and inlays of contrasting woods. Hepplewhite chairs have backs shaped like hearts, ovals, or shields and straight tapered legs.

Little is known about Hepplewhite's life. After 1760, he owned a workshop in London.

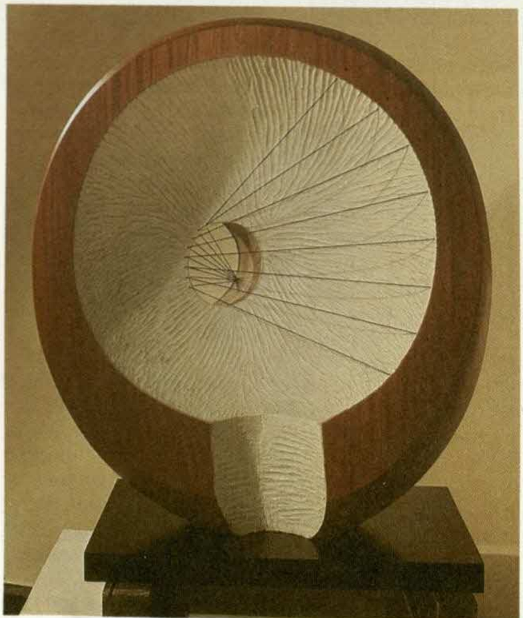
See also **Furniture** (English neoclassical furniture).

Heptagon is a plane figure with seven sides. It is a type of polygon. The sides of a heptagon meet at points called *vertices,* forming seven *interior angles* within the heptagon. The sum of the interior angles of a heptagon is always 900°. A heptagon is *regular* if it has equal sides and equal interior angles. The *apothem* of a regular heptagon is the distance from the centre of the figure to the midpoint of one of its sides. The area of a regular heptagon with side s and apothem a is found by the formula $\frac{7}{2}sa$.

Heptarchy was the name given to the seven most important English kingdoms that were established after the Anglo-Saxon conquest of Roman Britain. These kingdoms were founded by the Angles, Saxons, and Jutes. They were Kent, Essex, Sussex, Wessex, Northumbria (now Northumberland), East Anglia, and Mercia. They battled among themselves from about A.D. 600 to 829, when Egbert of Wessex established the supremacy of his kingdom. He thus became the first king of all England, but had little power. See also **Anglo-Saxons; Egbert.**

Heptathlon. See **Pentathlon.**

Hepworth, Dame Barbara (1903-1975), was a leading English sculptor. Her work does not fall into any distinct style. Some of her sculptures are based on human figures. She reduced them to a few basic forms, alone or connected to another figure or to its surroundings. Other sculptures are more abstract, made of smoothly carved wood or marble or bronze casts. Hepworth created these works in angular, circular, or spiral geometric shapes. They are almost always pierced with one or more holes to emphasize the tensions in the hollows.



Sculpture (1963) of wood and strings; Barbara Hepworth Museum, Cornwall, England (Tate Gallery)

A Hepworth sculpture called *Pierced Hemisphere (Telstar)* is made of smoothly carved wood. Like many of Hepworth's other abstract works, the sculpture is circular and pierced with a hole.

Jocelyn Barbara Hepworth was born in Wakefield in West Yorkshire, a part of England with rolling landscapes that she said influenced her work. At the outbreak of World War II in 1939, Hepworth moved to the village of St. Ives in Cornwall with her husband, painter Ben Nicholson. Cornwall's rugged coastline and wild landscape also influenced her work. Hepworth died in a fire in her St. Ives studio. Her sculpture *Single Form* (1963) stands in the United Nations Plaza in New York City. She was made a DBE in 1965.

Hera was the sister and wife of Zeus, the king of the gods in Greek mythology. She was the queen of both the gods and humans. Hera protected women, especially in marriage and childbirth. Greek artists portrayed her as beautiful, dignified, and matronly. The Roman goddess Juno resembled Hera in many ways.

A number of myths describe Hera's ruthless hostility toward her husband's many mistresses. Zeus changed one of his mistresses, the beautiful princess Io, into a cow to hide her from Hera. But Hera found Io and sent the monster Argus, who had 100 eyes, to guard her. On Zeus's orders, the god Hermes beheaded Argus. Hera honoured Argus by putting his eyes on the tail of the peacock, her favourite bird. Hera also tormented Io by sending a gadfly to sting her.

See also **Juno; Io.**

Heracles. See **Hercules.**

Heraclitus was a Greek philosopher who was active about 500 B.C. He said that everything is made of fire. This makes him sound like the other early Greek philosophers, who looked for one material they thought must be common to all that exists. But Heraclitus' view was more sophisticated.

Heraclitus believed that strife is the basic condition of the natural world and that everything is in continuous motion and change. He made the statement that a person cannot step into the same river twice. Heraclitus believed that the unity of things lies not in a material substance, but rather in a delicate balance or tension of opposing forces. Fire—because it is always in motion—is a good symbol of Heraclitus' view of the universe.

Heraclitus was born in Ephesus, now in Turkey, of an aristocratic family. He was scornful of people and lived in isolation. In ancient times, he was called *the Obscure* because his philosophy was hard to understand.

See also **Pre-Socratic philosophy.**

Herald. In ancient times, direct communication between a ruler and the people was often impossible. The rulers used special officials, called *heralds,* to deliver messages and orders, and to announce decisions and events. In the Middle Ages, heralds became personal agents for the king and enjoyed great honour. It was a crime to interfere with their work or to harm them.

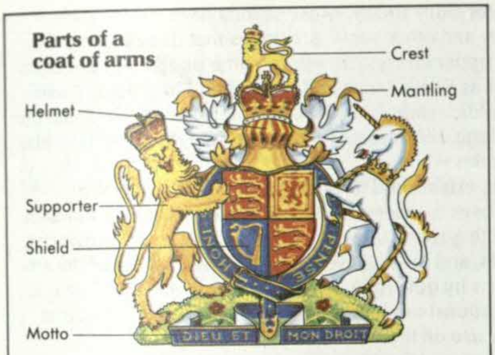
Medieval heralds became authorities on *coats of arms,* the emblems and designs used on the shields and clothing of nobles in battle. They supervised the selection of new designs to prevent duplication and to make sure that people did not claim ancestry to which they were not entitled.

See also **Heraldry.**

Heraldry is the study of a system of symbols used to represent individuals, families, countries, and such insti-

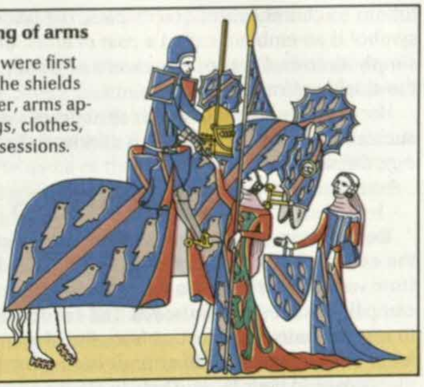
Symbols of heraldry

Parts of a coat of arms



The displaying of arms

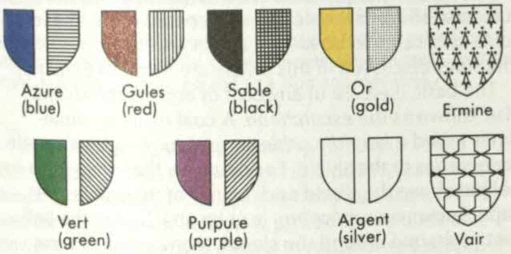
Coats of arms were first displayed on the shields of knights. Later, arms appeared on flags, clothes, and other possessions.



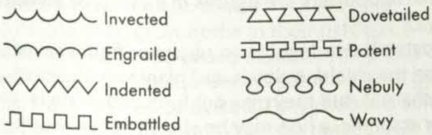
Symbols used on a coat of arms

Coats of arms were developed during the 1100's as a way to help a knight's followers recognize him on the battlefield. The colours, designs, lines, and *cadency* (status) symbols shown below became standard and were used in different combinations according to specific rules.

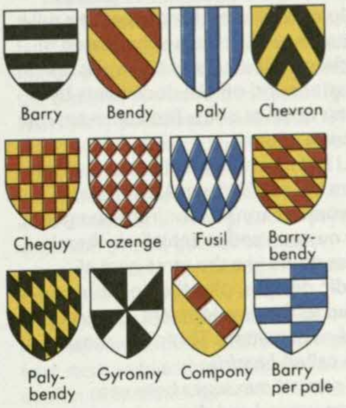
Colours and line equivalents **Metals** **Furs**



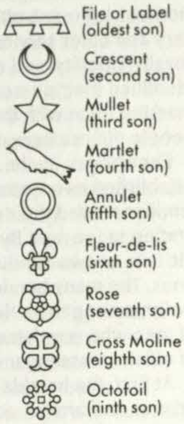
Lines to divide shields



Shield designs

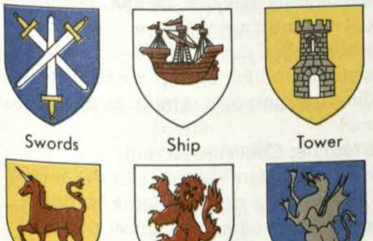


Cadency symbols



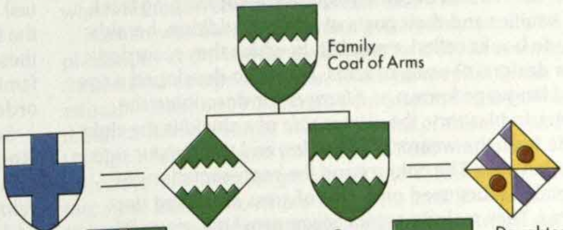
Kinds of charges

A charge is a symbol of an object or figure that appears on a shield. Animals are among the most popular charges.



Patterns of family relationships

Two or more arms were sometimes combined on one shield in order to show family relationships. The earliest methods of *marshalling,* as this procedure is called, are shown below. The arms of two families are placed side by side or one within the other.



tutions as churches and universities. The basic heraldic symbol is an emblem called a *coat of arms,* often known simply as *arms.* Coats of arms were originally used on the shields of knights.

Heraldry is related to similar systems of symbolism, such as seals and flags. It also is connected with *genealogy,* the study of family history.

The development of heraldry

Beginnings. The first coats of arms appeared during the early 1100's. They were used by Christian knights from western Europe who fought in a series of military campaigns called the *Crusades.* The Europeans wanted to regain control of Palestine from the Muslims. The knights wore heavy metal armour during battle, and helmets covered their faces. They displayed coats of arms on their shields and flags so their followers could recognize them on the battlefield.

Heraldry also served as a means of identification in civilian life. European societies were governed by a political and military system known as *feudalism.* Under feudalism, landowning nobles gave other nobles possession but not ownership of land in exchange for their military and other services. The upper classes consisted of royalty, nobility, and clergy. Members of these classes identified their possessions and official documents by marking them with their coats of arms. The common people did not have coats of arms.

Expansion. By the 1200's, heraldry had become firmly established as a system of identification. Upper-class families passed their coats of arms down from one generation to the next. By custom, and eventually by heraldic law, no two families could use the same coat of arms. The many heraldic designs, plus the possible confusion among them, led to the development of a group of men who regulated such matters. This class consisted of official messengers called *heralds.*

At first, the heralds carried messages between princes and armies, announced and directed tournaments, and conducted certain ceremonies. The heralds had to know one knight from another to perform their duties, and heraldic symbols provided the necessary identification.

The duties of the heralds increased as heraldry expanded to include more and more families. For example, the heralds became responsible for keeping track of families and their coats of arms. In addition, heralds made books called *armorials,* in which they recorded the designs of coats of arms. They also developed a special language known as *blazonry* for describing the arms. In blazonry, the *dexter side* of a shield is the right side from the wearer's viewpoint, and the *sinister side* is the left side. The colours and the representations of metals or furs used on a coat of arms are called *tinctures.* They include *argent* (silver or white), *azure* (blue), *gules* (red), *or* (gold), and *sable* (black).

After feudalism. During the 1200's and 1300's, feudalism began to decline in most European nations. At about the same time, armies developed new methods of warfare that did not require the use of coats of arms. However, heraldic symbols remained important in tournaments and in some ceremonies. The emblems served as decorations at such events and showed the importance of those who used them.

Heraldry today. Most nations have abolished heraldry and other social privileges that once belonged to the upper classes. However, some people in such countries as South Africa and the United Kingdom still use heraldic symbols to show their ancestry. In England, the College of Arms, also known as the College of Heralds, decides who has the right to use a coat of arms. The college, established in 1484 by King Richard III, also chooses the elements that must appear on the emblem.

The governments of many nations, states, provinces, cities, and towns have coats of arms. The use of the emblems by governments is called *civil heraldry.* Some international organizations also have coats of arms that they use on their stationery, for example.

In many countries, anyone may create and use a coat of arms. Such a self-created emblem is called *arms of assumption.* Many coats of arms for common family names are sold around the world, but few are authentic.

Elements of a coat of arms

By the late 1400's, heralds had established certain rules that affected the design of a coat of arms. These rules later came to be known as the *laws of heraldry.* The rules discussed in this article are those of England.

The basic element of any coat of arms is the *shield,* also known as the *escutcheon.* A coat of arms, sometimes called a *heraldic achievement,* may include certain *accessories* to the shield. For example, there may be a helmet above the shield and, on top of that, a crest. A cape, known as a *mantling,* may be attached to the helmet or draped around the shield. Many coats of arms have an accessory called a *supporter* on each side of the shield. Most supporters are figures of animals or human beings.

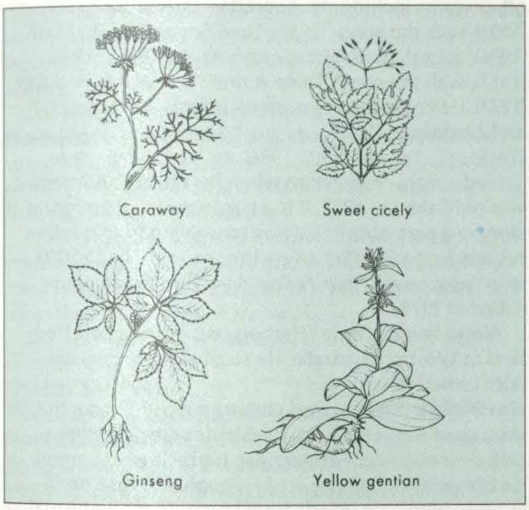
Most coats of arms include an object or figure called a *charge* on the shield. Animals and plants are the most common charges, but they may not look as they do in nature. For example, a lion may be shown *couped* (with the tips of its head or limbs cut off). Gods, people, monsters, and certain lifeless objects are also used as charges. The shield and all accessories stand on a base, known as the *compartment,* or above a motto, which is called the *device.*

A family's coat of arms may indicate the *cadency* (status) of individual members or of different branches of the family. Symbols called *marks of cadency* designate these family relationships. For example, each son in a family uses a different, personal symbol to show his order of birth.

See also **Cartouche; Chevron; Herald.**

Herb is a low-growing plant that has a fleshy or juicy stem when it is young. The stems of some herbs develop hard, woody tissue when they grow old. Most herbs are perennials. The tops of the plants die each growing season, but the roots remain alive and produce new plants year after year. Some herbs are annuals. They live for only one growing season and must be raised from seed each year.

The word *herb* comes from the Latin word *herba,* meaning *grass, green stalks,* or *blades.* Botanists use the word to mean any plant with soft, succulent tissues. But many people use the word to mean only herbs with some economic value.



Herbs have many uses. Caraway seeds, *top left,* add flavour to foods. The roots and seeds of sweet cicely, *top right,* also are used for seasoning. Ginseng roots, *bottom left,* are prized as a stimulant and as a cure for some ailments. Gentian roots, *bottom right,* serve as a flavouring and as a stomach medicine.

Some herbs are used in cooking to flavour foods. Others give scents to perfumes. Still others are used for medicines. Some herbs, such as balm and sage, are valued for their leaves. Saffron is picked for its buds and flowers. Fennel seeds are used in relishes and seasoning. Vanilla fruit pods yield vanilla flavouring. Ginseng is valued for its aromatic roots.

People often grow herbs in their gardens. Many kinds of herbs can also be raised indoors. The plants grow well with little care. Gardeners plant herbs in good soil that has been well cultivated. They choose a sunny spot that is easily accessible. When the herbs begin to grow, the gardener keeps the soil loose and free from weeds. The leaves, stems, or seeds of herbs can be used fresh, or they can be dried for later use. Dried herbs can be pounded to a fine powder, placed in airtight containers, and then stored. See **Gardening** (Food gardens).

Although herbs have little food value, they make food tasty and more flavourful. Cooking with herbs has become a culinary art, and it adds great variety to any menu.

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Tansy
Telegraph plant
Thyme
Valerian
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Herbarium is an organized collection of dried plants. Herbariums serve an important function in the study of plants. They offer an easy way to examine many different kinds of plants or many examples of one particular kind. Herbariums provide a valuable, permanent record of plant life.

Most specimens in a herbarium are glued to sheets of stiff paper. Some specimens, such as mosses, lichens, and fungi, are placed in folded paper packets. Each specimen is labelled with its name, the place and date of collection, the name of the collector, and other information. A good specimen shows all parts of the plant, such as the root, leaf, flower, and fruit. If they are protected from pests and moisture, specimens will last for hundreds of years.

The most valuable specimens in a herbarium are those from which the first descriptions of their kind were made. This is because the most common use of a herbarium is for naming unidentified plant specimens. By making comparisons with original specimens, botanists determine the best name to use for an unidentified specimen. Herbarium collections are also used in studies of plants of a particular kind or of a particular area. A good herbarium has many specimens of each kind of plant from the area in which it is located.

The largest collection (6 million specimens) is held by the herbarium of the Royal Botanic Gardens, Kew, England. Other extensive herbariums are held at the Komarov Botanic Institute in St. Petersburg, Russia, and at the National Herbarium in Washington, D.C.

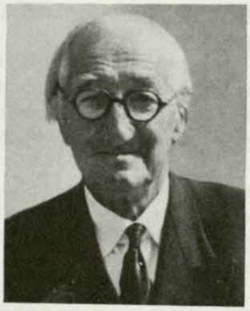
Herbart, Johann Friedrich (1776-1841), was a German philosopher and educator who greatly influenced educational theory of the late 1800's. He believed that education is closely related to *ethics* (the study of standards of right and wrong) and to psychology. Ethics provides the overall goal of education—to build strong moral character. Psychology furnishes the means of achieving this goal.

Herbart stressed the importance of developing and maintaining students' interest in learning. He called for four steps in teaching. First, the teacher presents information to students. Second, the instructor helps students analyse the new material and compare or contrast it with ideas they have already learned. Third, the teacher and the class use the new information to develop a general rule or principle. Fourth, the teacher helps students apply the new information in other situations or use the rule to solve other problems. Many educators in Europe and North America adopted Herbart's four steps, which his followers later expanded into five.

Herbart was born in Oldenburg, Germany. He studied philosophy at the University of Jena. In 1797, he went to Switzerland as a private tutor. There he met the Swiss educator Johann H. Pestalozzi, who inspired many of his theories. Herbart taught education and philosophy at the University of Göttingen from 1802 to 1809 and at the University of Königsberg from 1809 to 1833. He then returned to Göttingen, where he taught until his death.

Herbert, Sir Alan Patrick (1890-1971), a British author, poet, and politician, made legal history with his campaign to reform Britain's divorce laws. In the House of Commons, he introduced a private member's bill that later became law as the Matrimonial Causes Act, 1937. The Act did much to make divorce simpler. Earlier, Herbert had highlighted some of the problems and hardships caused by the existing divorce laws in his novel *Holy Deadlock* (1934). Herbert won a high reputation for his witty, light verse, often signed just with the initials

A. P. H. He wrote more than 50 books and the words of many musical plays, including *Tantivy Towers* (1930) and *Bless the Bride* (1947). Herbert was educated at Winchester College and Oxford. He was a Member of Parliament from 1935 to 1950.


Sir Alan Herbert

Herbert, George (1593-1633), was a leading English poet of the 1600's. His major volume of poems, *The Temple* (1633), was published shortly after his death and achieved wide popularity and influence. In this collection of 164 short lyric poems, Herbert skilfully and lovingly described what he called "the many spiritual conflicts that have passed betwixt God and my soul."

Herbert wrote mainly about religious subjects. In the poem "Jordan (II)," he declared, "There is in [God's] love a sweetness ready penn'd" that the poet needs only to "copy out." Herbert used great metrical variety, employing more than 140 different stanza patterns. He used intimate, sometimes homely imagery to express himself in poetry of great depth and emotional precision. Herbert's poems include "The Altar," "The Collar," "The Pulley," and three separate poems called "Love." In addition, he wrote the well-known hymn "Let All the World In Every Corner Sing."

Herbert was born into a noble Welsh family. He served in Parliament in 1624 and 1625. In 1626, he was ordained a deacon in the Church of England. He then worked his way through the spiritual conflicts described in *The Temple* and became rector at Bemerton, near Salisbury, in 1630. That same year, he was ordained to the priesthood.

See also **Metaphysical poets.**

Herbert, Victor (1859-1924), an American composer and conductor, is often called "the prince of operetta." One of his operettas is *Babes in Toyland* (1903), which was based on the nursery rhymes of Mother Goose and fairyland characters. "March of the Toys" and "Toyland" are well-loved numbers in this operetta. He also wrote *Mlle. Modiste* (1905), which includes the popular song "Kiss Me Again." *Naughty Marietta* (1910), one of the most tuneful of his operettas, includes such songs as "Ah! Sweet Mystery of Life," "I'm Falling in Love with Someone," "Italian Street Song," and " 'Neath the Southern Moon."

Herbert was born in Dublin, Ireland. He studied the cello in Germany, and played in leading European orchestras. In 1886, he settled in New York City, where he played cello in the Metropolitan Opera Company Orchestra. In 1893, Herbert followed Patrick S. Gilmore as bandmaster of the Twenty-second Regiment Band. He wrote *Prince Ananias,* his first operetta to be staged, in 1894. It was not a great success, but *The Wizard of the Nile,* a year later, proved popular.

Herbert was appointed conductor of the Pittsburgh Symphony Orchestra in 1898, but resigned in 1904 to devote his time to composition. He was the first American composer to write an original score for a film. His other works include the operettas *The Fortune Teller* (1898), with the song "Gypsy Love Song"; *The Red Mill* (1906); *Sweethearts* (1913); *Princess Pat* (1915); *Eileen* (1917), with the song "Thine Alone"; and *The Dream Girl* (1924). He composed two grand operas, *Natoma* (1911) and *Madeleine* (1914).

Herbert, Xavier (1901-1984), an Australian author, gained a major reputation when his novel *Capricornia* was published in 1937. It is a tragicomic and indignant story of a part-Aboriginal boy struggling to find self-respect in the Northern Territory society. His 850,000-word epic novel, *Poor Fellow My Country,* was published in 1975.

Alfred Francis Xavier Herbert was born at Port Hedland in Western Australia. He studied pharmacy but later turned to writing.

Herbicide is a chemical compound used to control or destroy unwanted plants. Herbicides are sometimes called *weedkillers.* Farmers use herbicides to control weeds growing among crops. People also use herbicides to eliminate weeds from lawns, parks, industrial sites, and other areas.

There are two types of herbicides, *selective* and *nonselective.* Most herbicides are selective—that is, they kill weeds but do not harm crops. Nonselective herbicides destroy all plants. Nonselective herbicides called *total weedkillers* are used along driveways, railways, and other places where people do not want any plants to grow.

Herbicides have been used since the early 1850's, when salt was spread to control unwanted plants. Salt, copper sulphate, and other early herbicides were nonselective. Selective herbicides came into use in the 1940's with the development of *2,4-D.* This herbicide is still used to kill some broadleaf weeds.

How herbicides work. Herbicides are manufactured in the form of a powder or a liquid. They are diluted in water and sprayed on growing weeds or on the soil. Many herbicides control weeds by preventing weed seeds from sprouting. These herbicides are mixed into the soil before or at the same time that crops are planted, or applied to the soil surface before crops and weeds start to grow. Some herbicides kill plants by hindering photosynthesis, the process by which plants convert carbon dioxide and water into food. Others, called *growth regulator herbicides,* cause plants to die prematurely by altering their growth patterns. Most growth regulator herbicides are applied after the crop or weed appears above the soil surface.

Hazards of herbicides. In many countries, environmental protection bodies now regulate the use of herbicides and register their safe uses. Most approved herbicides do not endanger human beings, animals, or the environment if used as directed by the manufacturer. However, some herbicides are poisonous and must be used with extreme care. All herbicides should be stored where children and animals cannot get to them.

In the 1960's and 1970's, a mixture of the herbicides 2,4-D and 2,4,5-T was widely used to *defoliate* (cause leaves to fall off) trees and brush. During the Vietnam War, this mixture became known by the military code name *Agent Orange.* United States forces sprayed it on the jungle vegetation in Vietnam to expose enemy snipers. During the early 1970's, researchers found that

Agent Orange and all other 2,4,5-T products contained a highly poisonous substance called *dioxin.* Dioxin contamination was a possible health hazard to people and animals.

See also **Agent Orange; Dioxin; Pesticide.**

Herbivore is any animal that chiefly eats plants. Herbivores are also called *herbivorous animals.* Animals that primarily eat flesh are called *carnivores.* Those eating flesh and plants are *omnivores.*

There are many kinds of herbivores. Some, such as cattle, deer, and horses, eat grasses. Others, including many birds, eat seeds. Earthworms are among the herbivores that eat dead plant material.

See also **Carnivore; Mammal** (illustration: The teeth of mammals); **Omnivore.**

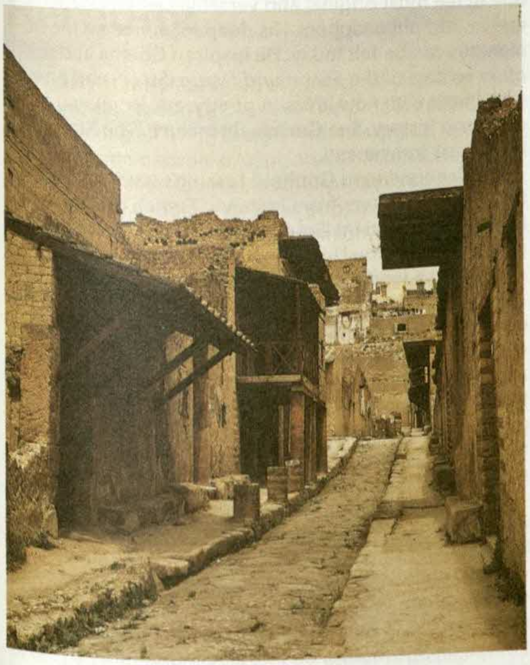
Herbs. See **Herb.**

Hercegovina. See **Bosnia-Herzegovina.**

Herculaneum was an ancient Roman city in Italy. Like Pompeii and Stabiae, it was buried when Mount Vesuvius erupted in A.D. 79. But the mud and lava that buried Herculaneum also preserved it as a record of life in ancient times. Fifteen hundred years later, archaeologists dug through the hardened layers of mud and lava and found priceless manuscripts, works of art, and tools of daily life.

Herculaneum was a small, pleasant city with a good harbour. It stood at the foot of Mount Vesuvius, 10 kilometres from Naples. The city had strong fortifications and was the home of many artistic treasures. Herculaneum was badly shaken by an earthquake in A.D. 63, but the damage was repaired.

Sixteen years later came the volcanic eruption that buried Herculaneum, Pompeii, and Stabiae, killing thousands of people. Pompeii and Stabiae were covered by ashes and lava. They were not as well preserved as Herculaneum, which was buried under a flow of lava and mud that was 30 metres deep in some places.



A street in Herculaneum looks much as it did in ancient times. Archaeologists have excavated many parts of the Roman city, which was buried when Mount Vesuvius erupted in A.D. 79.

A village later grew up near the site of Herculaneum. In the early 1700's, a farmer sank a shaft for a well, and found marble statues far below the surface. Soon afterward, someone sank another shaft, and discovered a theatre. The government of Naples took up the task of excavation in 1738. The deposits were much deeper at Herculaneum than at Pompeii, so digging was more difficult. Excavation was stopped in the 1800's but resumed in 1926 by the Italian government.

The site is now honeycombed by tunnels which robbers dug. It is believed that thieves have carried off many priceless works of art. But the excavators found wonderful marble and bronze statues, paintings, and papyrus rolls. Most of these precious works are now housed in a permanent exhibition at the National Museum in Naples.

See also **Pliny; Pompeii; Vesuvius.**

Hercules is a constellation of the Northern Hemisphere between Corona Borealis and Lyra. It is best seen high overhead in summer. The red star marking the head of Hercules lies toward the south. It is actually a pair of stars (see **Binary star**). The red star is a giant star, hundreds of times larger than the sun. In the northwest side of Hercules, a cluster numbering more than 100,000 stars appears. It is so far away that light requires more than 30,000 years to reach the earth. Even under good conditions, the cluster is barely visible to the naked eye.

In 1934, a star in Hercules suddenly began to grow brighter. It increased in intensity until it looked brighter than the North Star. Such a star is called a *nova.* Novas have appeared in other constellations during this century, but all have now faded and telescopes are needed to see them (see **Nova**).

Hercules was one of the greatest heroes of Greek mythology. The Greeks called him *Heracles,* but he is usually referred to as *Hercules,* the name used by the Romans.

Early life. Hercules was born in Thebes. He was the son of the princess Alcmene, a mortal, and Zeus, the king of the gods. Hera, the wife of Zeus, was jealous of Alcmene and hated Hercules. She persecuted Hercules throughout his life.

When Hercules was an infant, Hera sent two serpents to kill him. However, Hercules strangled the snakes. As a young man, Hercules had a vision. In it, he was offered a choice of a life of ease, pleasure, and vice, or one of hardship, danger, glory, and virtue. He chose the more difficult—but virtuous—life.

The twelve labours. Hera caused Hercules to have a fit of madness, during which he killed his wife, Megara, and their children. The oracle at Delphi told Hercules that he had to serve King Eurystheus of Tiryns for 12 years to purify himself of the murders.

Eurystheus commanded Hercules to perform 12 labours, which are described, with many variations, by a number of ancient authors. This section deals with the most generally accepted versions of the labours.

The first six labours took place near Thebes. First, Hercules killed the fierce lion of Nemea, whose skin he then wore as a trophy. Next, with the help of his nephew Iolaus, Hercules slew the deadly Hydra of Lerna. This serpent had several heads that grew back as soon as they were cut off. Hercules cut off the heads, and Iolaus sealed each neck with fire to prevent them from growing back. The hydra also had one head that was immortal, which Hercules buried under a rock. He then used the hydra's blood to poison his arrows.

For the third and fourth labours, Hercules captured the huge boar of Erymanthus and the golden-horned Arcadian stag. For his fifth labour, he drove a flock of ferocious birds away from the woods near Lake Stymphalus. These birds had arrowlike feathers that they shot at people. Next, Hercules cleaned the stables of King Augeas, which had not been washed out for many years, by making two rivers flow through them.

The second six labours took Hercules increasingly farther from his home. For the seventh labour, he travelled to Crete to capture the bull of King Minos. For the eighth, Hercules brought the horses of King Diomedes of Thrace to Eurystheus. These horses ate human beings, but Hercules tamed them by feeding them Diomedes. For the ninth labour, Hercules obtained the *girdle* (belt) of Hippolyta, the queen of the Amazons, by defeating her in battle (see **Amazons**).

To perform the 10th and 11th labours, Hercules journeyed to the western edge of the ancient world. First, he captured the cattle of the fearful monster Geryon. Then he stole the Golden Apples of the Hesperides from the Tree of Life (see **Hesperides**). For his 12th labour, Hercules descended into the world of the dead, captured the three-headed watchdog Cerberus, and brought him back to the upper world (see **Cerberus**).

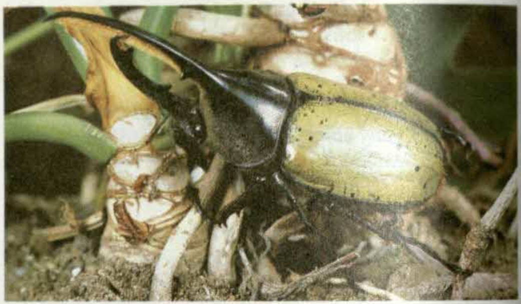
The last three of the twelve labours represented the conquest of death, and Hercules achieved immortality by carrying them out.

Other adventures of Hercules included accompanying the Argonauts on part of their voyage in search of the Golden Fleece. He also restored Alcestis, the wife of King Admetus, to life by outwrestling Death. Hercules released Prometheus from the punishment to which Zeus had condemned him. Also, Hercules fought the giant Antaeus, whose strength was renewed by contact with his mother, Earth. Hercules overcame Antaeus by holding him off the ground until he weakened. See **Argonauts; Prometheus.**

The death of Hercules. Some time after completing the 12 labours, Hercules married the princess Deianira. The centaur Nessus tried to rape Deianira, and Hercules shot him with a poisoned arrow. The dying centaur told Deianira to smear some of his blood on Hercules' robe if she ever needed to win back his love. After Hercules fell in love with another princess, Iole, Deianira followed Nessus' advice. But the centaur's blood had been poisoned by Hercules' arrow. When Hercules put on the robe, it burned him so terribly he pleaded to be placed on a funeral pyre. His body was consumed by flames, and he was taken to Olympus, home of the gods. There, he became a god.

See also **Atlas** (god); **Cornucopia; Hebe; Renaissance** (picture: Mythological subjects).

Hercules beetle is the name of several species of large beetles whose males have long horns that project from the head and upper parts of the body. The horns may make up over half the beetle's length. Adult Hercules beetles live for only one season. They feed mainly on ripe fruit in the canopy of trees. The larvae feed on rotten wood for one or two years.



A male Hercules beetle has long, curved horns that project from the head and upper body. In some species, the horns make up more than half the beetle's length.

The largest beetle in the world is a species of Hercules beetle found in Central America and the northern part of South America. It measures over 19 centimetres long. One large North American species is the *eastern Hercules beetle,* also known as the unicorn beetle. It is about 7 centimetres long. It lives mainly in the southeastern United States.

Scientific classification. Hercules beetles belong to the scarab beetle family, Scarabaeidae. They are genus *Dynastes.* The largest Hercules beetle is *D. hercules.* The eastern Hercules beetle is *D. tityus.*

Herd. See **Animal** (Flocks, herds, and schools).

Herder, Johann Gottfried von (1744-1803), was one of the most original and versatile German writers, critics, and philosophers. His deep influence on the humanities can be felt today. He inspired Goethe and the other writers of the *Sturm und Drang* (Storm and Stress) movement with new ideas in poetry, art, language, religion, and history. See **German literature** (The Storm and Stress movement).

Herder continued Gotthold Lessing's work in trying to free German writers from imitating French classicism, based on the ancient Greeks. He argued that Shakespeare, Ossian, the Hebrew poets, and folk songs equalled the works of the Greeks.

His translations of Shakespeare and the songs of many nations formed models for translations by the German romanticists who followed him. His *Ideas to a Philosophy of History* (1784-1791) contributed important theories on the development of civilization. He explained cultural evolution as part of the evolution of nature, rather than a manifestation of the rational free will of human beings.

Herder was born in Mohrungen, East Prussia, the son of a poor schoolteacher. He worked to finance his education. At the University of Königsberg, he studied theology and philosophy. Immanuel Kant was one of his teachers there. After four successful years as a teacher and preacher in Riga, Russia, Herder travelled through Europe. In Strasbourg, he met Goethe, and they became friends. Through Goethe's influence, Herder was appointed general superintendent of churches and court preacher at Weimar in 1776.

Heredity affects all living things. Heredity explains why human mothers always have human children and cats always have kittens, *left.* The process of heredity also occurs among all plants and even among one-celled organisms, such as a paramecium, *right.*

Heredity

Heredity is the passing on of biological characteristics from one generation to the next. The process of heredity occurs among all living things—animals, plants, and even such microscopic organisms as bacteria. Heredity explains why every human mother produces a human baby and why a mother dog has puppies and does not have kittens. It is also the reason offspring look like their parents.

Through heredity, living things inherit characteristics, often called *traits,* from their parents. You resemble your parents because you inherited your hair colour, nose shape, and other traits from them. All organisms consist of cells. Tiny biochemical structures inside each cell called *genes* carry traits from one generation to the next. Genes are made of a chemical called *DNA (deoxyribonucleic acid).* They are strung together to form long chains of DNA in structures known as *chromosomes.*

Genes are like blueprints for building a house, except that they carry the plans for building cells, tissues, organs, and bodies. They have the instructions for making the thousands of chemical building blocks in the body. These building blocks are called *proteins.* Some proteins are responsible for the size, shape, and structure of the parts making up your body. Other proteins, known as *enzymes,* make possible the thousands of chemical reactions that occur constantly in your body and in all other living things. The process by which the cell makes a protein according to the instructions carried by a gene is known as *gene expression.*

Genes have powerful effects, but they do not control all of life. Most characteristics result from a combination of heredity and environment. For example, you may have inherited a talent for playing the piano. But you will not be able to play unless you have access to a piano, take lessons, and practice. The talent is hereditary. The lessons, practice and availability of a piano are environmental.

The basic laws of heredity were formulated during the mid-1800's by an Austrian botanist and monk named Gregor Mendel. Mendel based his laws on his studies of the inheritance patterns of garden peas. Although Mendel published the results of his experiments in 1866, his work went unnoticed by other scientists until 1900.

Mendel's experiments laid the foundation for the scientific study of heredity, called *genetics.* Through the years, *geneticists*—that is, people who study heredity—have learned much about why human beings and other living things look and behave the way they do. These scientists have also begun to uncover the causes of hereditary diseases and to develop ways to treat them. Today, genetics has several specialized branches. *Molecular genetics,* for example, involves the study of the chemical nature and activities of genes. For more information on the various branches of genetics, see **Genetics.**

Chromosomes and genes

The structure of chromosomes and genes. In human beings and most other organisms, chromosomes are found in the part of a cell known as the *nucleus.* Chromosomes are tiny threadlike structures made largely of DNA and proteins. Chromosomes generally occur in pairs. The two chromosomes in a pair resemble each other in size and shape. They also contain similar hereditary information.

Each species of animal and plant has a characteristic number of chromosomes in its *body cells.* Body cells, often called *somatic cells,* are the cells that make up such body parts as muscles and bones. Body cells differ from *sex cells.* In male animals, the sex cells are sperm; in plants, pollen. In female animals and plants, the sex cells are eggs. Human beings typically have 46 chromosomes, arranged in 23 pairs, in their body cells. Dogs have 78 (39 pairs), and maize has 20 (10 pairs). The fruit fly *Drosophila melanogaster,* which is widely used in genetic research, has only 8 chromosomes (4 pairs).

Genes are the basic units of heredity. Each gene consists of a section of an extremely long DNA molecule found in a chromosome.

Every species of plant and animal has a certain number of genes on its chromosomes. For example, scientists estimate that human beings have from 50,000 to 100,000 different genes. The fruit fly has about 5,000 different genes, dogs have from 50,000 to 100,000 genes, and maize has about 60,000 genes. A set of all the genes that a species has on its chromosomes is called its *genome.*

Sex cells and reproduction. There are two general types of reproduction, *asexual* and *sexual.* Asexual reproduction involves only one parent. The offspring have chromosomes identical to those of the parent. When a worm called a planarian reproduces asexually, for example, its body divides into two sections. One has the head, and the other has the tail. Each section grows the parts that are missing and becomes a new individual that is genetically identical to its parent.

Sexual reproduction generally involves two parents, each of which contributes half the chromosomes to the offspring. Sexual reproduction starts with the production of specialized sex cells that are called *gametes.* Gametes—that is, sperm, pollen grains, and eggs—are produced in a process of cell division called *meiosis.* Meiosis results in the sex cells' having half the number of chromosomes found in the body cells. In human beings, therefore, meiosis produces sperm and egg cells that have 23 chromosomes each. In dogs, the number of chromosomes in each sex cell is 39.

The uniting of an egg cell and a sperm cell, called *fertilization,* restores the full number of chromosomes. In human beings, the resulting cell, known as a *fertilized egg,* has 46 chromosomes, 23 pairs. One chromosome of each pair comes from the mother's egg, and the other from the father's sperm. After the egg has been fertilized, it begins to divide and produce exact copies of itself by a type of cell division called *mitosis.* Each of the new cells, known as *daughter cells,* has the same number of chromosomes as the original cell. For further

Heredity terms

Alleles are different forms of the same gene.

Chromosomes are tiny threadlike structures inside each cell. Chromosomes carry the genes.

DNA stands for *deoxyribonucleic acid.* It is the substance within the chromosomes that carries the hereditary instructions for producing proteins and RNA's.

Gene expression is the process by which a cell makes a protein or RNA according to the instructions carried by a gene.

Genes are tiny biochemical structures inside each cell that determine particular hereditary traits, such as eye colour and blood type. Each gene is a segment of DNA that carries instructions for producing the chainlike molecules that make up proteins.

Genetic variation refers to the differences in inherited traits that exist among the members of a species.

Genetics is the scientific study of heredity.

Genome is a set of all the genes a species has on its chromosomes. The human genome consists of 50,000 to 100,000 genes.

Genotype is the underlying genetic makeup of a trait or the overall genetic makeup of an individual.

Mutation is a change in a gene. It may produce a new trait that can be inherited.

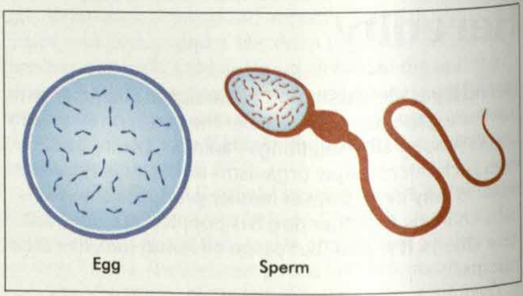
Phenotype is the observable appearance of a trait or the overall appearance of an individual.

Protein is a chemical building block in the body. Proteins exist in every cell.

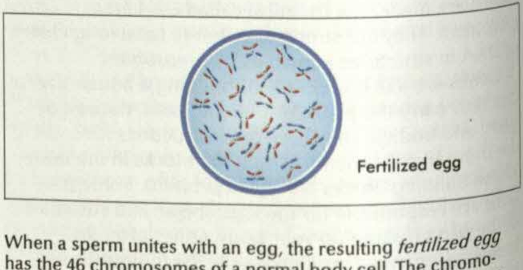
RNA stands for *ribonucleic acid.* Similar to DNA, it plays a key role in the production of proteins.

Trait is a characteristic, such as hair colour.

How chromosomes are inherited



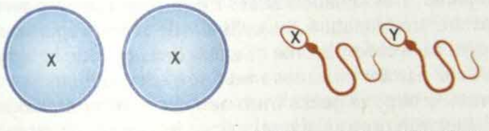
The sex cells—that is, eggs in females and sperm in males—are produced in a process called *meiosis.* As a result of this process, mature sex cells, such as those shown above, have half the number of chromosomes found in other cells in the body. Each human egg and sperm cell thus has 23 chromosomes.



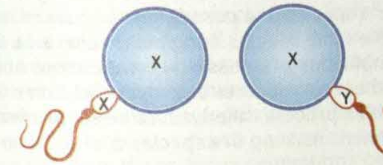
When a sperm unites with an egg, the resulting *fertilized egg* has the 46 chromosomes of a normal body cell. The chromosomes are arranged in 23 pairs. One chromosome in each pair comes from the mother, and the other comes from the father.

How a person's sex is determined

Chromosomes known as X and Y chromosomes determine whether a fertilized egg will become a girl or a boy. An immature female sex cell has matching X chromosomes. An immature male sex cell has an X chromosome and a Y chromosome.



When an immature female sex cell divides, each resulting mature egg cell receives a single X chromosome. When an immature male sex cell divides, half the resulting mature sperm cells receive an X chromosome, and half receive a Y chromosome.



An egg fertilized by a sperm cell containing an X chromosome has two X chromosomes, *left.* It will develop into a girl. An egg fertilized by a sperm with a Y chromosome has one X and one Y chromosome, *right.* Such an egg will develop into a boy.

information on meiosis and mitosis, see **Cell** (Cell division).

Chromosomes and sexual determination. In human beings, chromosomes known as X and Y chromosomes determine an individual's sex. Eggs always have an X chromosome, but sperm may have either an X or a Y chromosome. When a Y-carrying sperm fertilizes an egg, the baby will be a boy (XY). If the sperm has an X chromosome, then the baby will be a girl (XX). Males produce sperm with an X chromosome in numbers equal to sperm with a Y chromosome. As a result, about half of all babies are boys, and half are girls.

Patterns of heredity

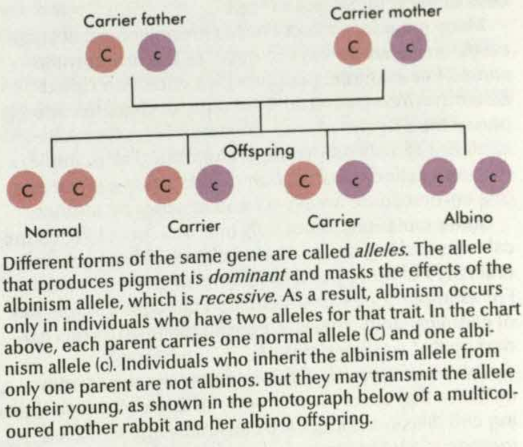
Dominant and recessive genes. Most genes occur in pairs. Each pair of genes is contained in a pair of matching chromosomes, with one copy of a gene in each chromosome. Some hereditary traits are determined by a single pair of genes. For example, a chemical called *phenylthiocarbamide* (PTC) tastes extremely bitter to some people. Other people cannot taste PTC at all. The difference between tasters and nontasters is the result of a single pair of genes. But many other traits, called *polygenic traits,* are influenced by a number of pairs of genes. Tens or hundreds of pairs of genes are involved in the inheritance of such traits as height, weight, and intelligence.

The two genes in a pair may differ in the effects they produce. Different forms of the same gene are called *alleles.* Some alleles are *dominant,* and others are *recessive.* A dominant allele masks the effects of its recessive partner. In other words, the dominant allele is expressed, and the recessive allele is not. A trait that results from a recessive allele is evident only in an individual that has two recessive alleles for that trait. For example, Mendel showed that in pea plants the allele that produces violet flowers (symbolized by *V*) is dominant over the one that causes white flowers *(v).* Pea plants that have two dominant alleles for violet flowers *(VV)* or one allele for violet flowers and one for white flowers *(Vv)* will have violet flowers. Only those with two recessive alleles *(vv)* will have white flowers.

Sex-linked genes. Genes that lie near each other on the same chromosome are called *linked genes* because they tend to be inherited together. Genes on the sex chromosomes are called *sex-linked genes.* Human beings have more than 250 genes on the X chromosome—called *X-linked* genes—that can cause hereditary disorders. These disorders include haemophilia and a type of muscular dystrophy. Most of these disorders are recessive. They typically occur only in males because males have only one X chromosome. Females have two X chromosomes. Generally, at least one of the two X chromosomes has the dominant normal allele. This allele deter-

The transmission of albinism

Albinism is a hereditary condition in which an organism cannot produce pigment. Albinism occurs in human beings and in many species of plants and animals.



Different forms of the same gene are called *alleles.* The allele that produces pigment is *dominant* and masks the effects of the albinism allele, which is *recessive.* As a result, albinism occurs only in individuals who have two alleles for that trait. In the chart above, each parent carries one normal allele (C) and one albinism allele (c). Individuals who inherit the albinism allele from only one parent are not albinos. But they may transmit the allele to their young, as shown in the photograph below of a multicoloured mother rabbit and her albino offspring.

mines the trait, and the harmful gene on the other X chromosome does not.

Sources of genetic variation

Individual members of a species differ widely from one another in their genetic makeup and therefore in their traits. You may look like your parents, but you are not an exact duplicate of either of them. You inherited half your genes from your father and half from your mother. Nor do you look exactly like your classmates, even though you and your classmates are all human beings. Scientists refer to the differences among members of a species as *genetic variation.* This section discusses the main sources of diversity among individual members of a species—mutation and genetic recombination. The next section, *Heredity and natural selection,* describes how entire species and certain groups within species change over time.

Mutation is a permanent change in the amount or the structure of the DNA in an organism's cells. It can result in alterations in gene expression and therefore in traits.

Kinds of mutations. Mutations can occur in sex cells or in body cells. A *germinal mutation* affects the DNA in the gametes and is therefore passed on from an organism to its offspring. A *somatic mutation* occurs in body cells. In human beings and other animals, somatic mutations do not affect the gametes. Consequently, the changes are not inherited by succeeding generations. However, the changes are passed along to the daughter cells of the original mutant cell.

Many mutations affect entire chromosomes. In some cases, an organism has too many or too few chromosomes. For example, people with a condition called *Down syndrome* have an extra copy of chromosome 21, one of the 23 pairs of chromosomes. Sometimes the structure of a chromosome is abnormal. For example, a mutation called *translocation* occurs when a piece of one chromosome breaks off and attaches to another.

Some mutations affect only one or a few of the chemical units making up the DNA molecule. There are several kinds of these *point mutations* or *gene mutations.* For example, a *missense mutation* changes a single pair of chemical units, thereby altering the instructions carried by that segment of DNA.

Causes of mutations. Some mutations result from mistakes that occur when copies of DNA are made during cell division. Others are caused by agents called *mutagens.* Mutagens include certain chemicals and various forms of radiation.

Genetic recombination. When organisms mate, new combinations of traits appear in their young. These combinations occur by (1) independent assortment of the genes on different chromosomes, and (2) crossing over.

Independent assortment refers to the way in which chromosomes and their genes are distributed when a sex cell divides to form eggs or sperm. An immature sex cell contains two of each chromosome—one from the individual's father and one from the mother. During meiosis, each pair of chromosomes separates, and each egg or sperm receives one chromosome from each pair. Because the chromosomes separate in a random manner, each egg or sperm receives some chromosomes from the individual's mother and some from the father. This reshuffling of chromosomes and genes can result in new combinations of traits in offspring.

Crossing over is the exchange of genes between two partner chromosomes. Genes on separate chromosomes are inherited in a random and independent manner. But genes located close to each other on the same chromosome are generally inherited together. In other words, genes that are closely linked on a parent's chromosome largely remain linked in offspring.

Sometimes, however, linked genes are not inherited together. This situation arises because of crossing over. Just before immature sex cells divide to form sperm or eggs, each chromosome of a pair lines up side by side with its partner chromosome. During a crossing-over event, groups of genes from one chromosome change places with groups of genes from its partner chromosome. As a result, different sperm or eggs may carry different combinations of linked genes.

Heredity and natural selection

Mutation is one of the chief sources of new genetic material for a species or a *population*—a group of individuals of the same species living in the same area. Genetic recombination provides new combinations of mutations. As these two sources of genetic variation work together with a process called *natural selection* over time, the genetic makeup of a species or population changes.

Natural selection. Many mutations that alter traits are harmful, but some mutations and combinations of mutations make certain individuals better able to survive, mate, and reproduce in a given environment. These individuals will likely have more offspring that survive than individuals without the particular genetic variation. The young of the better-suited parents inherit the genes for the favourable characteristics that enabled their parents to improve their chances of surviving, mating, and reproducing. They then pass the genes along to their own offspring. As this process is repeated through many generations, more and more members of the species or population come to have the favourable genes. In this way, the process of natural selection changes the genetic makeup and therefore the traits of organisms through time.

Generally, evolution by natural selection takes place slowly and is not noticeable in a human lifetime. However, a species may change quickly in response to a major alteration in the environment, such as pollution or the introduction of a pesticide.

An example of a rapid genetic change occurred in the United Kingdom during the 1800's with a species of moth called the peppered moth. Peppered moths rest on light-coloured lichens that grow on tree trunks. During the early 1800's, nearly all peppered moths were light-coloured, and only a few moths carried a mutation that made them black. In the mid-1800's, however, factories burned so much coal that soot settled over the countryside, killing the lichens and blackening the tree trunks. Light-coloured moths on dark-coloured trees were easily seen and eaten by birds. But the birds could not see the black moths well. As a result, more of the black moths survived and produced offspring. Within 50 years, most moths in heavily polluted areas were black.

After air pollution laws were passed in the mid-1900's, tree trunks became lighter as lichens again grew, and the number of light-coloured moths increased.

Gene pools and allele frequency. The genes of all the individuals of a population are called a *gene pool.* The degree to which a particular allele is present in a population is called the *allele frequency.* The level of diversity in a gene pool is important because genetic variation is necessary for a population to adapt to changes in the environment. For example, an insect population that has a genetic variant for resisting a new pesticide in its environment will be more likely to survive. There will be strong selection for that variant, and its frequency in the gene pool will increase. On the other hand, an insect population that does not have such a variant will die off.

Several factors besides natural selection may influence the frequency of particular alleles in a gene pool. These factors include *gene flow* and *genetic drift.*

Gene flow is the transfer of genes from one population to another. When separate populations come into contact and interbreed, new genes or combinations of genes are introduced into each group. Consequently, the gene pool of each group comes to include genes from pools of the other populations. In this manner, the allele frequencies of populations may change over time.

Genetic drift refers to chance increases or decreases in allele frequencies of a population from generation to generation. The genes of each generation represent only a sample of the previous generation's gene pool. As a result, the allele frequencies of each generation of individuals tend to vary randomly within the limitations of the preceding generation's gene pool. Such changes will probably have little effect on each generation in large populations. But they can lead to major genetic changes in small ones in a short period.

For a more detailed discussion of the factors involved in genetic variation among human populations, see **Races, Human** (How human populations develop and change).

Hereditary disorders

Many diseases and disorders are caused by such agents as viruses and bacteria. In other cases, however, the cause of the problem is hereditary—that is, the organism has inherited one or more abnormal genes from its parents. Because genes carry chemical instructions for the formation of proteins, defective genes can affect the production and function of proteins. For example, haemophiliacs are born with a defective gene, and thus they are unable to produce a protein crucial for blood clotting. As a result, they suffer prolonged bleeding when they are injured because their blood clots slowly.

Genes are arranged in an exact order along the length of the chromosomes. Researchers use a process known as *gene mapping* to locate and identify genes on a chromosome. This process has helped scientists determine which genes are responsible for some hereditary conditions. For example, Huntington's disease, a severe disorder of the nervous system, is caused by an abnormal gene on chromosome 4.

Many diseases, such as diabetes and rheumatoid arthritis, are common in certain families. These diseases are therefore believed to have a hereditary basis. People inherit a tendency to develop these conditions, but not the diseases themselves. Environmental factors may play a role in whether the conditions actually develop. For example, people with a genetic tendency toward diabetes may increase their chance of getting the disease by overeating and not getting enough exercise.

Scientists have developed methods of treating some hereditary disorders. For example, haemophilia can be treated by injections of the clotting factor that is missing from the blood of people who have the condition.

A technique known as *gene therapy* may offer a way

Inherited disorders

This table lists the symptoms and treatment of several hereditary disorders. As scientists learn more about genes, they are discovering that certain diseases have a genetic basis. For example, defective genes are responsible for some cases of breast cancer and of the brain disorder called Alzheimer's disease.

Name	Symptoms	Treatment
[*]**Cystic fibrosis**	Lung, pancreas, and liver damage owing to abnormal mucus production	Drugs, physical therapy; experimental gene therapy; no cure
[†]**Duchenne muscular dystrophy**	Progressive weakening of the muscles	Drugs, physical therapy; no cure
[*]**Haemophilia**	Uncontrolled internal and external bleeding	Controlled by injections of missing blood-clotting factor
[*]**Huntington's disease**	Loss of muscle control and mental ability, usually in midlife	None
[*]**Phenylketonuria**	Mental retardation	Special diet to prevent onset of symptoms
[*]**Retinoblastoma**	Cancer of the eye in childhood	Radiation, drugs, surgery; usually curable if caught early
[*]**Sickle cell disease**	Anaemia, blood clots, damage to organs and nervous system	Drugs to ease symptoms; no cure
[*]**Tay-Sachs disease**	Severe brain damage in infancy	No treatment or cure

[*] Has a separate article in *World Book*.
[†] See Muscular dystrophy.

of treating hereditary disorders and certain other diseases. Such therapy involves identifying the gene that causes a genetic disease and then supplying patients with a normal copy of that gene. The normal genes come from another individual or organism and are usually inserted into a patient's cells outside the body. The altered cells are then returned into the patient's body. See **Gene therapy.**

Couples who are planning to have children can be tested to see if they carry certain potentially harmful genes. These tests are usually done as part of a process called *genetic counselling.* This process enables couples to understand their chances of bearing children with hereditary disorders. It also helps them learn ways of dealing with their situation. See **Genetic counselling.**

Heredity and environment

A gene gives only the potential for the development of a trait. How this potential is achieved depends partly on the interaction of the gene with other genes. But it also depends partly on the environment. For example, a person may have a genetic tendency toward being overweight. But the person's actual weight will depend on such environmental factors as how much and what kinds of food the person eats.

The underlying genetic makeup of a trait is called the *genotype.* The actual appearance of the trait is known as the *phenotype.* Sometimes the word *phenotype* is used to refer to the overall appearance of an individual; *genotype,* to refer to the person's overall genetic makeup.

Scientists have long debated the relationship between heredity and environment in determining a person's physical appearance and behaviour. This debate is often referred to as the question of *nature versus nurture*—that is, heredity versus environment.

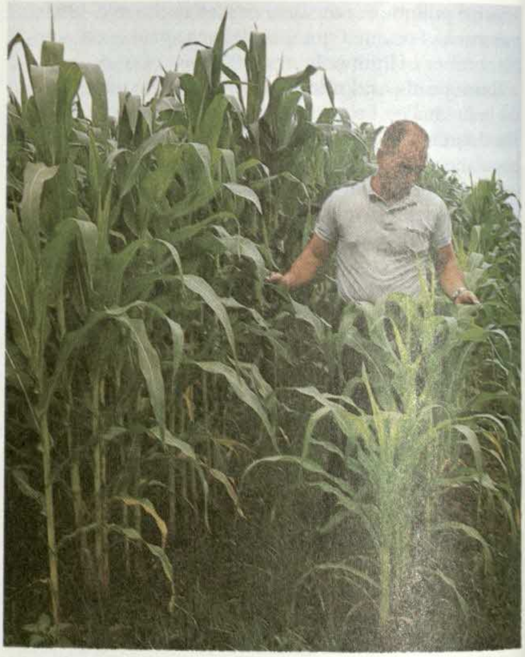
To try to understand the influence of genetics and the environment on phenotype, researchers have often studied identical twins, who have the same genotype. Such studies have shown that identical twins raised apart and thus in different environments tend to vary more in their characteristics than identical twins raised together. As a result, scientists have concluded that both heredity and environment play important roles in what an individual's ultimate phenotype will be.

Intelligence and other mental traits also depend on heredity and environment. Every person is born with a certain mental capacity that influences how intelligent he or she will be as an adult. The development of this capacity is influenced by the person's environment. For example, severely undernourished infants may fail to develop their natural abilities.

The flow of genetic information

Genes and proteins. Genes carry the instructions for producing proteins. Proteins are large, complex molecules made up of smaller units called *amino acids.* Twenty kinds of amino acids are commonly found in proteins. Various combinations of these amino acids are linked to form long chains known as *polypeptides.* Polypeptide chains fold into complex three-dimensional shapes.

Proteins consist of one or more polypeptide chains. These chains vary greatly in length, from only a few amino acids to thousands. They also differ according to the order in which the amino acids occur. The length of the polypeptide chains and the arrangement of their amino acids determine the protein's shape and function. In most cases, one gene is responsible for making one polypeptide. The gene determines the order and number of amino acids in the polypeptide and thus the shape and function of the protein.



The effects of environment can be seen in these maize plants. All were grown from identical seeds and so have identical *genes* (units of heredity). However, the plants on the right grew in soil that lacked some nutrients needed for proper growth.

Proteins are found in every cell and are essential to plant and animal life. The proteins called *enzymes* speed up the chemical processes of life. Without enzymes, most of the reactions that occur in living things would happen too slowly to make life possible. These reactions include breaking down food during digestion and burning carbohydrates and fat for energy.

Many other proteins serve as building blocks for cells. Cells have different sizes and shapes—and different kinds, numbers, and arrangements of proteins—depending on where they are in an organism. Hair, nails, and part of the skin are made of a tough protein called *keratin.* The red colour in blood comes from a red protein called *haemoglobin* that carries oxygen from the lungs to all parts of the body. Muscles consist largely of two proteins called *myosin* and *actin.*

The structure of DNA. The genes of all living things except some viruses are composed of DNA, which is often referred to as the *hereditary material.* DNA is a thin, chainlike molecule made up of smaller chemical units called *nucleotides.* A nucleotide in DNA is composed of a sugar known as *deoxyribose,* an oxygen-phosphorus chemical group called a *phosphate,* and a nitrogen-containing compound known as a *base.* The sugar and phosphate are the same in all DNA nucleotides, but the bases vary. There are four DNA bases: adenine (A), guanine (G), thymine (T), and cytosine (C).

DNA consists of two chains that coil around each other in a shape called a *double helix.* The double helix resembles a twisted ladder. The sides of the ladder consist of the linked sugars and phosphates of the nucleotides. Each rung is made up of two paired bases.

Base pairs. The bases of a DNA molecule are paired in a specific way to form combinations known as *base pairs.* There are A-T and G-C base pairs. Wherever there is adenine in one strand, there is thymine in the opposite strand. Wherever there is guanine in one strand, there is cytosine in the other. Other combinations are extremely rare. Because of this specific pairing of the bases, scientists say the two DNA strands are *complementary.* The sequence of bases in one strand determines the sequence of bases in the other.

DNA molecules in human beings typically have more than 100 million base pairs and measure more than 2.5 centimetres long when uncoiled. However, DNA is so thin it can be seen only with the aid of special microscopes called *electron microscopes.* A typical DNA molecule has a thickness of only 20 *angstroms.* One angstrom equals 0.0000001 millimetre.

Replication. Most of the cells in your body divide from time to time. When you get a cut, for example, the skin cells around the wound begin to divide to make new skin to repair the damage. Each of the new daughter cells produced by cell division has the same DNA as the old cells.

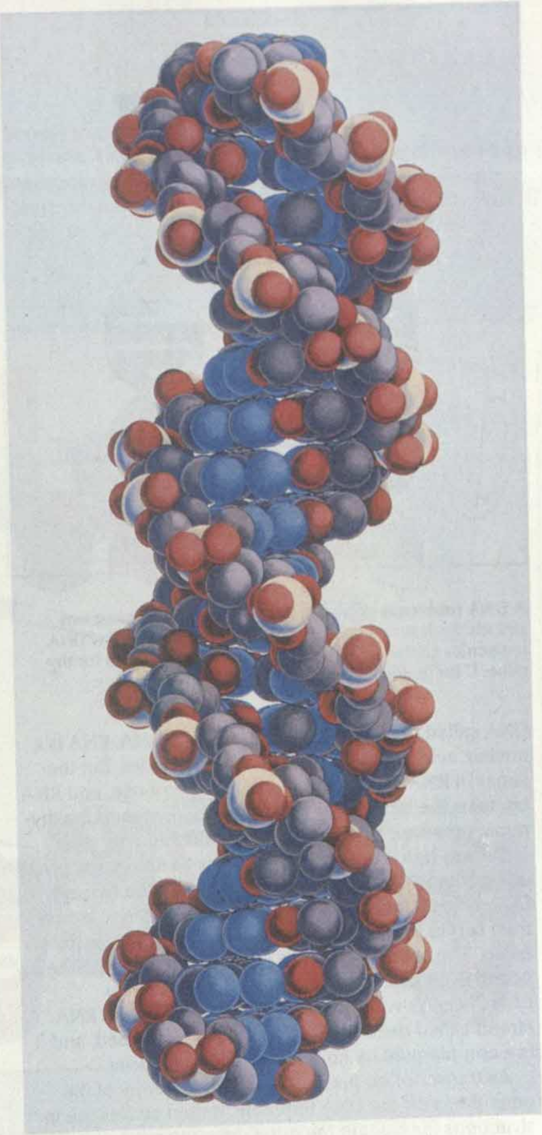
The process by which exact copies of DNA are made during cell division is called *replication.* The accurate replication of DNA is one of the essential characteristics of the hereditary material. Without it, daughter cells would be genetically different from each other and from the parent cell. Your genetic makeup, and therefore your physical characteristics, would be constantly changing as your cells divided.

The complementary nature of the two DNA strands enables a cell to make exact copies of its DNA. Before the cell divides, sections of the two original joined strands of a DNA molecule split lengthwise, separating the base pairs. This process is similar to what would happen if a ladder split down the middle, separating its rungs. Each of the DNA strands, which resembles a half ladder, then picks up free nucleotides from the cell nucleus. The bases in the free nucleotides, with their attached sugars and phosphates, pair with the matching bases on the original DNA strands. A's pair with T's, T's with A's, G's with C's, and C's with G's. In this way, two double-stranded DNA ladders are produced that have exactly the same base sequence as the parent DNA. When the cell divides, each of the new daughter cells receives identical DNA molecules.

How proteins are made. The *genetic code* is a code formed by the sequence of the bases in DNA. This code tells the cell how to put amino acids together in the right order to make a specific polypeptide.

A group of three bases in a certain order forms a unit of the genetic code called a *codon.* Most codons specify a certain amino acid. The order of codons on DNA determines the sequence of amino acids in a protein—and the protein product that is made.

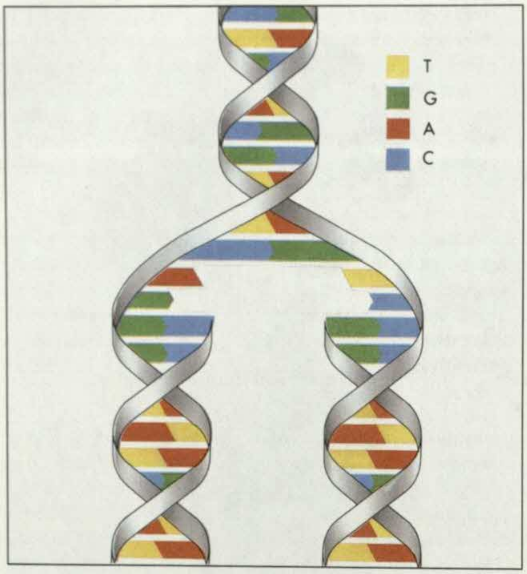
A total of 64 three-letter codons, often called *triplets,* can be formed from the four letters of the DNA bases. Because there are only 20, not 64, amino acids, there is more than one codon for most amino acids. In addition, with only minor exceptions, the same three-letter codons specify the same amino acids in all organisms that have been studied. Therefore, the genetic code is nearly universal.



A model of a DNA molecule shows that DNA is shaped like a twisted ladder. The coloured spheres represent the various types of chemical units that make up DNA. This model was proposed in 1953 by biologists Francis Crick and James Watson.

Gene expression, the process by which the cell makes a protein according to the instructions carried by a gene, takes place in two steps. These steps are known as (1) *transcription* and (2) *translation.*

Transcription involves a close chemical cousin of



A DNA molecule duplicates by splitting and forming two strands. Each strand links to new strands, forming new DNA molecules containing the same information. T stands for thymine, G for guanine, A for adenine, and C for cytosine.

DNA called *RNA (ribonucleic acid)*. Like DNA, RNA is a nucleic acid and is composed of nucleotides. But the sugar in RNA is ribose instead of deoxyribose, and RNA contains the base *uracil* (U) instead of thymine. Like thymine, however, uracil base-pairs with adenine.

During transcription, a cell makes an RNA copy of one of the DNA strands of a gene. Part of the twisted DNA ladder unwinds and splits. One of the half ladders then serves as a *template* (mold) for lining up the RNA bases. The bases of the free nucleotides pair with the exposed DNA bases. For example, the RNA bases CUACAG pair with the DNA bases GATGTC. An RNA strand called *messenger RNA* (mRNA) is formed, and it is a complementary copy of the DNA blueprint.

As transcription proceeds, the mRNA copy of the gene peels off the DNA template. It then carries the instructions for making the gene's protein product to the cell's protein factories, which are structures known as *ribosomes*. The ribosomes are outside the nucleus in a part of the cell called the *cytoplasm*. The mRNA acts as a guide to line up the amino acids in the order called for by the gene, forming the correct protein chain.

Translation. In the translation step of gene expression, the ribosomes "read" the code in the mRNA and link amino acids in the order the mRNA codons dictate. Another type of RNA, called *transfer RNA* (tRNA), plays a key role in translation. Transfer RNA brings amino acids to the ribosomes from other parts of the cytoplasm.

A molecule of transfer RNA has two sites with important roles in translation. One site contains an *anticodon*, which consists of three nucleotides. The bases in the nucleotides of each tRNA anticodon are complementary to those in an mRNA codon and can therefore base-pair with them. The other important site is at one end of the tRNA molecule. The tRNA binds to a specific amino acid at this site. For example, tRNA with the anticodon CGU binds to the mRNA codon GCA, which codes for the amino acid alanine. The end of the tRNA binds to alanine. Thus, this tRNA can deliver alanine to the ribosome.

The mRNA moves through a ribosome one codon at a time. After a codon arrives at the decoding centre of the ribosome, a tRNA molecule brings in the appropriate amino acid. In this way, the polypeptide grows, one amino acid at a time, until the ribosome reaches the end of the message in the mRNA. The last codon of the message signals that the chain is complete and tells the ribosome to stop production.

After the ribosome reads the stop codon, the finished polypeptide chain is released. The ribosome can then begin producing another polypeptide. In most proteins that consist of more than one polypeptide chain, the chains are manufactured separately, and then they combine to make the protein.

History of the study of heredity

Early ideas about heredity. One of the oldest known theories of inheritance was proposed by the Greek philosopher Aristotle, who lived during the 300's B.C. Aristotle taught that traits are inherited through the blood. This theory was wrong, but it was generally accepted for more than 1,000 years.

A correct theory of inheritance could not be formulated until after sex cells had been discovered and their functions determined. The discovery of eggs and sperm occurred during the late 1600's. At that time, many biologists thought that either the egg or the sperm contained a tiny but fully formed embryo that merely increased in size inside the mother. In the late 1700's, Caspar Friedrich Wolff, a German scientist, proved embryos are not preformed. He showed that an embryo grows from a fertilized egg, and he argued that the sperm and the egg contribute equally to the embryo.

During the early 1800's, a French biologist and nobleman, the Chevalier de Lamarck, suggested that traits acquired during the lifetime of an organism could be passed on to its offspring. Later genetic discoveries showed that transmission of such acquired characteristics from one generation to the next does not occur.

However, Lamarck's theory was basically accepted by the British biologist Charles Darwin, who proposed the theory of natural selection in his book *The Origin of Species* (1859). Darwin believed each part of the body produced tiny particles that moved through the bloodstream into the eggs or sperm. These particles supposedly influenced hereditary traits. The British scientist Francis Galton, a cousin of Darwin's, disproved this idea. Galton transfused blood from black rabbits into white rabbits to see if the white ones would have black babies. But the white rabbits still produced white offspring.

Mendel's laws. During the mid-1800's, Gregor Mendel, an Austrian botanist and monk, conducted a series of experiments on inheritance. Working in his monastery garden, he studied traits in pea plants. The results of these experiments led Mendel to formulate the first correct theory of heredity. This theory consisted of two principles called *Mendel's laws of heredity*.

Mendel's first law, the Law of Segregation, has three parts. (1) Hereditary characteristics are determined by

A *World Book* science activity

Studying heredity

The purpose of this activity is to study the interaction of heredity and environment in determining *phenotype*—that is, the observable characteristics—of organisms. The project looks at how various environmental factors influence the development of potato plants. *Eyes* (buds) that grow out of the same potato have the same *genotype*—that is, the same genetic makeup. Eyes can grow into new potato plants. By planting the eyes of a potato and changing such environmental conditions as light, water, and temperature, you can see how environmental factors influence characteristics.

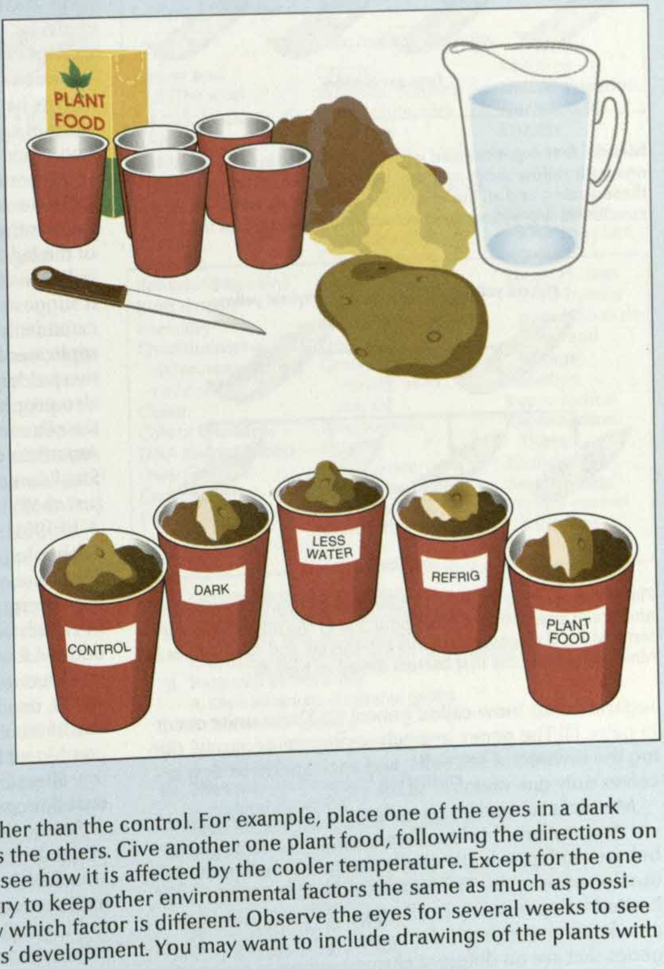
What you need

An old potato with several eyes

A knife

Several wax paper or plastic cups

Potting soil, sand, water, plant food, and other materials you decide to use



Activity procedure

Cut the potato so that each eye has about the same amount of potato attached to it.

Fill several of the wax paper or plastic cups with the same mixture of potting soil, sand, and water. (Potato plants grow best in slightly sandy soil and at temperatures that range from 16 to 21 °C.)

Plant the potato pieces so the eyes are just above the surface of the soil. Provide one of the eyes with everything that you think it needs to grow well, such as sufficient light and water. This eye will be your *control* for the experiment—that is, it will be the standard to which you compare the other eyes.

Alter one condition for each of the eyes other than the control. For example, place one of the eyes in a dark closet. Give one only half as much water as the others. Give another one plant food, following the directions on the package. Put one in the refrigerator to see how it is affected by the cooler temperature. Except for the one condition that you change for each plant, try to keep other environmental factors the same as much as possible. Label each container so that you know which factor is different. Observe the eyes for several weeks to see how they grow. Keep a record of the plants' development. You may want to include drawings of the plants with this record.

Results and questions

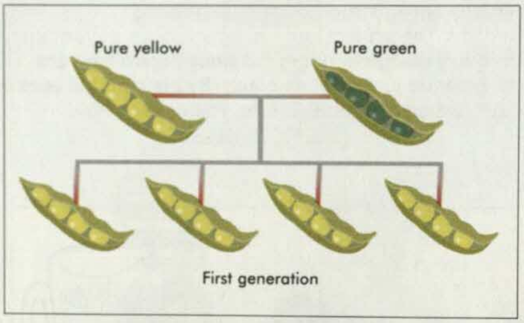
After several weeks have passed, analyze the material you have collected. Are there differences in the way the individual plants have grown? Does any one environmental factor seem more influential than others in determining the plants' development? Do individuals with the same genetic makeup necessarily have the same observable characteristics? What relationship can you now conclude exists between genotype and phenotype?

Extending the activity

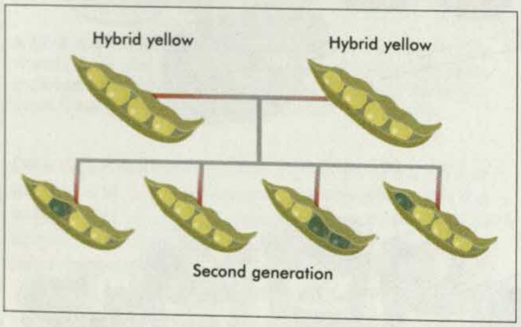
Think about genotype and phenotype in terms of human beings. Consider such factors as food and shelter as being part of a person's environment. Do you think that you would look and act differently if you had the same genotype but grew up in another kind of home and ate different types of food? How would you be different? Can you think of other factors that are part of your environment?

Mendel's experiments on heredity

In the mid-1800's, Gregor Mendel, an Austrian botanist and monk, studied traits in pea plants. The diagrams below show the main steps in Mendel's experiments on seed colour.



Mendel first experimented with purebred strains of pea plants—one with yellow seeds and one with green seeds. He crossed these strains, and all the resulting hybrid seeds were yellow. He concluded that yellow seed colour was the dominant trait.



Plants grown from the hybrid yellow seeds produced yellow and green seeds in a ratio of about 3 to 1. The inheritance patterns Mendel discovered in this experiment and similar ones led him to formulate the first correct theory of heredity.

separate units (now called genes). (2) These units occur in pairs. (3) The genes in a pair *segregate* (separate) during the division of sex cells, and each sperm or egg receives only one member of the pair.

Mendel's second law is called the Law of Independent Assortment. This law states that each pair of genes behaves independently of all other pairs during the production of sex cells. Therefore, each pair of genes is inherited independently of all other genes. Geneticists now know that independent assortment applies only to genes that are on different chromosomes or far apart on the same chromosome. Genes that are linked, or near each other on the same chromosome, tend to be inherited together.

The birth of genetics. Mendel published a report of his work in 1866. But it went unnoticed until 1900. Then, three European botanists studying heredity each rediscovered Mendel's work. These three scientists were Hugo de Vries of the Netherlands, Carl Correns of Germany, and Erich von Tschermak of Austria. They conducted plant-breeding experiments and independently got results similar to those Mendel had obtained.

Many important genetic discoveries quickly followed the rediscovery of Mendel's principles. During the early 1900's, a group of scientists directed by Thomas Hunt Morgan at Columbia University in New York City discovered many important aspects of heredity. These researchers included Calvin Bridges, Hermann Muller, and Alfred Sturtevant. Morgan and his co-workers studied the inheritance of such traits as eye colour and wing shape in fruit flies. They showed that genes were on chromosomes, made the first genetic map, demonstrated the inheritance of genes on sex chromosomes, and discovered crossing over. In 1931, the American geneticist Barbara McClintock demonstrated that crossing over involves the physical exchange of chromosomal material.

The chemistry of genes became the focus of much research in genetics after 1940. By the early 1950's, scientists had proved that genes control chemical reactions in cells by directing the production of enzymes and other proteins. They had also determined that DNA is the hereditary material.

Two scientists, James Watson of the United States and Francis Crick of the United Kingdom, proposed a model of the ladderlike chemical structure of DNA—the double helix—in 1953. Their model was a breakthrough because it suggested for the first time how DNA can be replicated faithfully. Watson and Crick suggested that DNA replicates by splitting down the middle and building two ladders by matching complementary halves. They also proposed that mutations result from a change in the sequence of bases along the ladder. In 1958, the American geneticists Matthew Meselson and Franklin Stahl demonstrated experimentally that DNA replicates just as Watson and Crick had proposed.

In 1961, scientists working at the California Institute of Technology reported their discovery of messenger RNA. That same year, the American biochemist Marshall Nirenberg and his colleagues at the National Institutes of Health (NIH) identified the first word of the genetic code—UUU. By 1967, the entire code had been broken.

The era of genetic engineering. Since the early 1970's, much of the study of heredity has involved the use of techniques known as genetic engineering or recombinant DNA technology. Recombinant DNA technology alters the genes in organisms to produce molecules called *recombinant DNA*.

Scientists produce recombinant DNA by first using enzymes called *restriction enzymes* to cut the chromosomal DNA from a plant or animal into pieces. They then make a recombinant DNA molecule by chemically attaching these smaller pieces to special DNA molecules called *vectors*. Vectors have the ability to enter cells and replicate. Next, scientists transplant the recombinant DNA into a bacterial or yeast cell. When these cells reproduce, researchers can obtain a huge number of identical cells that contain the recombinant DNA. A group of genetically identical cells is known as a *clone*.

Experiments with recombinant DNA have revealed much about the structure and function of genes. Recombinant DNA technology also has important medical applications. In 1982, genetically engineered insulin for diabetics became the first recombinant DNA drug approved by the United States Food and Drug Administration (FDA) for use on people. Other genetically engineered drugs followed. They include human growth

The Human Genome Project is designed to create a genetic map of the entire set of human genes. This researcher is dissecting a chromosome for study as part of the project.

hormone (hGH), which is used to treat children whose growth is seriously below average; *tissue plasminogen activator,* used to treat heart attacks by breaking up blood clots; and *interferon,* used for halting the spread of viruses from cell to cell.

Another important medical application of recombinant DNA technology is gene therapy. In 1990 and early 1991, researchers at the NIH used gene therapy on patients for the first time. They treated two young girls who had faulty genes for the enzyme *adenosine deaminase* (ADA). The genes produced a deficiency of the enzyme, which caused the girls to have severely weakened immune systems. The researchers used a modified virus to deliver a normal copy of the ADA gene to the girls. A few months after gene therapy, both girls had properly working immune systems. However, the therapy did not cure their condition, and the girls needed to receive periodic additional treatment. In 1993, NIH researchers used gene therapy for the first time on a patient with cystic fibrosis, a hereditary disorder that causes a life-threatening build-up of thick mucus in the lungs.

By the mid-1990's, teams of geneticists had identified and cloned the genes that control several other serious genetic disorders. They include amyotrophic lateral sclerosis (ALS), Duchenne muscular dystrophy, and Huntington's disease.

Recombinant DNA technology has agricultural applications as well. Researchers are experimenting with using genetic-engineering techniques to improve certain features of crops, including the ability of plants to resist diseases and pests. In 1994, the American Food and Drugs Administration approved for sale a genetically engineered tomato that is supposed to have an improved shelf life and flavour.

The Human Genome Project. In the late 1980's, scientists in the United States and a number of other nations launched the Human Genome Project. This project is designed to create a genetic map of the entire set of human genes—the 50,000 to 100,000 genes of the human genome. Another of its goals is to determine the base sequence of the 3 billion base pairs in all the DNA in a human cell. Geneticists hope that a genetic map will help them identify more genes associated with diseases. They believe that the sooner these genes are located and identified, the sooner they can design strategies to try to cure the diseases. In 1993, a group of French scientists announced that they had produced a rough map of the human genome.

Related articles in ***World Book*** include:

Biographies

Beadle, George W.
Burbank, Luther
Crick, Francis H. C.
Darwin, Charles R.
De Vries, Hugo
Franklin, Rosalind
Galton, Sir Francis
Lamarck, Chevalier de
Lysenko, Trofim D.
Mendel, Gregor J.
Morgan, Thomas H.
Muller, Hermann J.
Watson, James D.
Weismann, August
Wilkins, Maurice H. F.

Genetic basis of heredity

Amino acid
Cell (The work of a cell; The code of life)
Chromosome
Enzyme
Evolution (Causes of evolutionary change)
Gene
Mutation
Natural selection
Nucleic acid
Protein

Other related articles

Albino
Atavism
Baldness
Behavior (Heredity)
Birth defect
Breeding
Child (Individual differences among children)
Clone
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DNA fingerprinting
Dwarf
Environment
Eugenics
Fruit fly
Gaucher's disease
Gene mapping
Gene therapy
Genetic counselling
Genetic engineering
Genetics
Growth (How growth takes place)
Haemophilia
Hybrid
Intelligence
Molecular biology
Multiple birth
Plant (Factors affecting plant growth)
Races, Human (How human populations develop and change)
Radiation
Reproduction
Reproduction, Human
Rh factor
Sociobiology
Weight control (Heredity)

Outline

I. Chromosomes and genes
  A. The structure of chromosomes and genes
  B. Sex cells and reproduction
  C. Chromosomes and sexual determination
II. Patterns of heredity
  A. Dominant and recessive genes
  B. Sex-linked genes
III. Sources of genetic variation
  A. Mutation
  B. Genetic recombination
IV. Heredity and natural selection
  A. Natural selection
  B. Gene pools and allele frequency
V. Hereditary disorders
VI. Heredity and environment
VII. The flow of genetic information
  A. Genes and proteins
  B. The structure of DNA
  C. How proteins are made
VIII. History of the study of heredity

Questions

What is the *genetic code*? A *codon*?
How many chromosomes does each human body cell contain?
What are *X-linked genes*? Why do disorders caused by X-linked genes generally occur only in males?
How do DNA and RNA differ in structure?
What is the Human Genome Project?
What is the difference between a *genotype* and a *phenotype*?
Why is the complementary nature of DNA strands important?
What is *genetic engineering*? *Gene therapy*?
How does a crossing-over event occur?
What is a *germinal mutation*? A *somatic mutation*?
How does gene flow affect the makeup of a gene pool?

Hereford (pop. 50,200) is a city and local government district in the county of Hereford and Worcester, England. It stands on the River Wye. It has a cathedral built mainly in the Norman and Decorated style. The cathedral contains carved stalls, a medieval map of the world, and King Stephen's chair, made in the 1100's. The Bishop's Palace has a timbered hall, built in the 1100's. The Three Choirs Festival is held at Hereford every third year. See also **Hereford and Worcester.**

Hereford and Worcester is a county in the English Midlands, lying just east of the Welsh border. Its rich soil makes it one of the best farming areas in the United Kingdom. Orchards of apple, pear, or plum trees, fields of hops, market gardens, fields of grain, and grazing cattle are characteristic of the unspoilt countryside of Hereford and Worcester.

Until the early 1970's, the area that is now Hereford and Worcester formed two separate counties—Herefordshire, administered at Hereford, and Worcestershire, administered at Worcester. The two counties were merged in 1974 to form the new county of Hereford and Worcester. At that time, some towns that had been part of Worcestershire were taken into the new county of West Midlands. These towns were Dudley, Halesowen, Stourbridge, and Warley.

People and government

Local customs. Unusual customs in renting land still survive among the market gardeners in the Evesham area. A tenant who wishes to leave has the right to introduce a new tenant to the landlord at any time. If the new tenant has good references, the landlord must accept the new tenant or *pay out* the old tenant. Paying out involves giving the old tenant a large sum to end the tenancy. The sum is related to the value of the land, including any improvements which the old tenant has made. A tenant is almost as secure as if he owned the land.

Recreation. Association football is played in almost every village. Professional teams include Hereford United in the Football League. Redditch and Worcester have teams that play in the Premier Division of the Beazer Homes League. Strong rugby clubs are at Droitwich, Evesham, Hereford, Kidderminster, and Worcester.

Cricket is popular throughout the county. Notable cricket grounds are at Hereford, Kidderminster, and Worcester.

River sports are well provided for in Hereford and Worcester. Rowing clubs are at Bewdley, Evesham, Hereford, Stourport, and Worcester. Many people fish in the rivers Avon, Lugg, Severn, Teme, and Wye. Fox-hunting and point-to-point steeplechasing are popular. Worcester has a course for steeplechasing.

The annual Three Choirs Festival of choral music is held in turn at the cathedrals of Hereford, Worcester, and Gloucester in nearby Gloucestershire. In 1977, the Malvern Festival, founded in 1928, was revived after a lapse of some years.

Local government. The county council provides some public services throughout the county. The county is divided into nine districts: *Bromsgrove; Hereford; Leominster; Malvern Hills; Redditch; South Hereford; Worcester; Wychavon,* which includes Droitwich, Evesham, and Pershore; and *Wyre Forest,* including Kidderminster. Redditch became a *new town,* a place for rapid population growth, in 1964. The crown court meets at Worcester, which is also the county council headquarters. Near the city are the headquarters of the county's police force, the West Mercia Constabulary.

Facts in brief about Hereford and Worcester

Administrative centre: Worcester.
Largest towns: Worcester, Kidderminster, Hereford, Redditch.
Area: 3,925 km².
Population: *1991 census*—667,800.
Chief products: *Agriculture*—asparagus, barley, dairy cattle, fruit, hops, market gardening, oats, pigs, poultry, sheep, sugar beet, wheat. *Manufacturing and processing*—canning, carpets, china, cider, food processing, frozen food, light engineering, vacuum cleaners. *Mining and quarrying*—limestone, moulding sand, sand and gravel.

Economy

Agriculture. Half the county area under crops is used for growing barley, oats, and wheat. The other half of the arable land is used for a wide variety of vegetables, fruit, and other crops, including rapeseed.

Hereford and Worcester is an important fruit-growing county. The main fruit-producing areas are the Vale of Evesham; Pershore, which specializes in plums; and the Teme Valley. Most growers produce apples, pears, raspberries, and strawberries.

Hops, used in brewing, are grown around Worcester, in the Teme Valley, and in the extreme south of the county. Farmers cultivate asparagus in the Vale of Evesham and sugar beet around Kidderminster.

The Herefordshire breed of cattle is world-famous. These brown-and-white cattle are widely raised in the southern parts of the county for their beef. The breed has been reared in the area since the 1600's. Farmers keep some dairy cattle, pigs, and poultry, especially in the south. Sheep are reared mostly in the west.

Manufacturing. Manufacturing industries include those linked with agriculture, such as cider making, canning, jam making, food processing and producing fro-

Hereford and Worcester is an English county which lies on the border with Wales.

Malvern Hills run right through the middle of the county of Hereford and Worcester. The hills are a pleasant area for walking, and they attract many visitors during the summer.

zen food. Workers at Worcester manufacture porcelain and containers for fruit and vegetables. Kidderminster has factories producing sugar from sugar beet and is a large centre for the carpet industry. Redditch is increasingly becoming a centre for high-technology industry and its engineering works supply many components for the car industry. The county produces sand, gravel, and limestone and its beautiful scenery attracts many tourists.

Transportation and communication. The county has good transport links to the north and south. A main line railway from Birmingham to Bristol runs through Worcester. A line links Worcester to Hereford, running on to South Wales, and north from Hereford to Shrewsbury. The M5 motorway runs near Bromsgrove, Droitwich, and Worcester, linking them with Birmingham to the north and Bristol to the south. Branching off the M5 to the west is the M50 running towards Ross-on-Wye and to the east is the M42 running round the south of Birmingham towards Nottingham.

A daily newspaper is published at Worcester. Most of the towns publish weekly newspapers. An independent local radio station, Radio Wyvern, serves the area around Great Malvern, Hereford, and Worcester.

Land

Location and size. One of the largest of England's counties, Hereford and Worcester measures about 110 kilometres from east to west at its widest point. Its greatest measurement from northwest to southeast is 72 kilometres.

Hereford and Worcester's neighbouring areas are Shropshire, Staffordshire, and West Midlands to the north, Warwickshire to the east, Gloucestershire to the south, and the Welsh counties of Gwent and Powys to the southwest and west.

Land features. The Clent and Lickey hills rise in the north. The Clent Hills reach 313 metres. In the south of the county are Bredon Hills and the edge of the Cotswolds. The Malvern Hills, which rise to 425 metres at Worcestershire Beacon, extend across the centre of the county. The Wye Valley near Ross-on-Wye has spectacular limestone cliffs.

Rivers. The largest river is the Severn. The Avon joins the Severn at Tewkesbury. In the north, the Teme joins the Severn near Worcester. The River Wye forms part of the county's southern boundary.

Climate. Hereford and Worcester is one of Britain's warmest inland counties, with average temperatures of about 4° C in February and 17° C in July. Snow or sleet falls on only about 14 days in a year.

The county's average rainfall is about 710 millimetres. October and January are the wettest months. June is both the sunniest and the driest month.

History

The Romans founded the city of Worcester. The Saxons founded the first settlement at Hereford in the A.D. 600's. The Danes invaded the area in the 900's.

The Normans built castles at Hereford, Weobley, and Wigmore. In early Norman times, the church controlled most of the county. In the Barons' War, the barons were defeated in 1265 at the Battle of Evesham by Prince Edward, later Edward I. Between the 1200's and the 1400's, there was fighting with the Welsh. More fighting occurred in the Wars of the Roses.

In 1637, Worcester was ravaged by plague. In the Civil War, the county was loyal to the Royalists. Hereford and Worcester were both besieged. Eventually the Civil War ended at the Battle of Worcester in 1651. The city was plundered and the cathedral damaged.

Famous people associated with the county include the British prime minister Stanley Baldwin, who was born at Bewdley; David Garrick, the Shakespearean actor of the 1700's, who was born at Hereford; the composer Sir Edward Elgar, who was born near Hereford; and the poet laureate John Masefield, who was born near Ledbury.

Royal Worcester Pottery produces much fine china. A master decorator, *above,* paints the decoration onto a vase.

Related articles in *World Book* include:

- Baldwin, Stanley
- Danegeld
- Elgar, Sir Edward
- Garrick, David
- Hereford
- Leominster
- Masefield, John
- New towns
- Poet laureate
- Worcester

Hereford cattle. See **Cattle** (Hereford).

Heresy is an opinion or idea that contradicts the beliefs of a religious group or closely knit organization. A person guilty of heresy is called a *heretic.* The Christian church once punished heretics with exile, torture, or even death. Churches today sometimes expel heretics. See also **Albigenses; Arianism; Eckhardt, Johannes; Inquisition; Roman Catholic Church** (The early church; Jansenism).

Hereward the Wake (1032?-1072?) was a Lincolnshire landowner who became a leader of English resistance to William the Conqueror in 1070 (see **William** [I]). He joined forces with a group of Danish raiders based at the Isle of Ely. With them, he attacked Peterborough and sacked its abbey. He and his raiders were such a threat to William's control of the area that William made a treaty with the Danish king, Sweyn, who withdrew his raiders from Ely. But Hereward remained, and Ely became a refuge for William's enemies.

Hereward carried on guerrilla warfare against William, who laid siege to Ely in 1071. Most of the garrison surrendered, but Hereward escaped into the fen country inland. He became an English folk hero and the subject of many popular legends. Charles Kingsley gathered some of them together in his novel *Hereward the Wake* (see **Kingsley, Charles**).

Herm. See **Channel Islands.**

Herman, Sali (1898-), an Australian artist, won the Wynne Prize for landscape painting in 1944, 1963, and 1965. His work reveals his fascination for the clustered architecture and fronts of old buildings in the inner Sydney suburbs of Woolloomooloo, Darlinghurst, and Paddington. His technique of scraping and glazing is similar to that of the French artist Maurice Utrillo.

Sali Yakubowitsch Herman was born in Zurich, Switzerland. He travelled extensively in Europe, North and South America, and Africa before settling in Australia in 1937. He trained under George Bell in Melbourne. In 1938, Herman moved to Sydney, where he became a leading figure in the modern art movement.

Herman, Woody (1913-1987), was an American bandleader and musician. He ranks with Duke Ellington and Count Basie as one of the three most durable figures in the history of big-band jazz. Herman's bands made several musicians and composers famous, including saxophonists Stan Getz, Flip Phillips, Zoot Sims, and Al Cohn; trumpet players Sonny Berman and Pete Condoli; trombonist Bill Harris; and composers Neal Hefti and Ralph Burns. Herman also won praise playing alto saxophone and clarinet with his bands.

Herman's two most influential bands were known as the First Herd (1944-1946) and the Second Herd (1947-1948). Herman was one of the first bandleaders to use elements of a jazz movement of the 1940's called *bebop,* or *bop,* as well as classical music. The Russian-born composer Igor Stravinsky composed his *Ebony Concerto* (1946) for Herman's band. Herman developed an unusual reed section for the Second Herd consisting of three tenor saxophones and a baritone saxophone. The section was known for its bright, lyrical phrasing in such numbers as "Four Brothers."

Woodrow Charles Herman was born in Milwaukee, Wisconsin. He formed his first big band, known as "The Band That Plays the Blues," in 1936. It became famous in 1939 with its recording of "Woodchoppers' Ball."

See also **Jazz** (picture: Woody Herman).

Hermaphrodite is an animal with both male and female organs of reproduction. Some flatworms and segmented worms are normally hermaphrodites, as are some echinoderms and molluscs.

Although some hermaphrodites fertilize their own eggs, most do not. Some show *successive hermaphroditism,* in which the two sets of organs produce egg and sperm at different times. In others, the positions of the sex organs keep the animals from fertilizing themselves. For example, the common earthworm has active male and female organs located in different parts of the body. This allows two worms to fertilize each other, but prevents them from fertilizing themselves.

In the higher animals, hermaphroditism is not normal. The organs and functions of one or both sexes usually develop imperfectly in such rare individuals. Few human cases of hermaphroditism have been reported.

Hermes was the messenger of the gods in Greek mythology. He protected travellers, and the Greeks believed he brought good luck, especially in business. Hermes sometimes acted in a deceitful or mischievous way, and so the Greeks also considered him a protector of thieves. Under the name of Hermes Psychopompos, he guided the souls of the dead to the lower world. Hermes resembled the Roman god Mercury.

One famous Greek myth tells how Hermes, on the day of his birth, stole the cattle of the god Apollo. But Hermes and Apollo became close friends after Hermes invented the seven-stringed lyre and gave it to Apollo, who loved music.

Greek art showed Hermes as a handsome youth, often wearing winged shoes and a winged hat. He carried a winged staff entwined with snakes.

See also **Hermes of Praxiteles; Mercury.**

The statue of Hermes and the infant Dionysus.

Hermes of Praxiteles is an ancient Greek statue of Hermes, the messenger of the gods in Greek mythology. The Athenian sculptor Praxiteles created the masterpiece, probably in the 330's B.C. (see **Praxiteles**). Although the original statue was lost, a copy exists that was created about 100 B.C., probably by the Greek sculptor Pasiteles. The copy has beauty and charm and possesses the dreamy expression and the graceful "S" curve of the body that are characteristic of Praxiteles' style. The statue portrays Hermes holding his infant brother, Dionysus, on one arm. In the other arm, which is now missing, Hermes held a bunch of grapes that he offered to the infant.

Hermione was the daughter of Menelaus and Helen of Troy. She was promised as wife to Orestes, the son of Agamemnon. But Menelaus gave her to Neoptolemus, son of Achilles. Neoptolemus was murdered at Delphi, probably by Orestes. Hermione then married Orestes. See also **Menelaus; Orestes.**

Hermit is a person who lives a solitary life, removed from social contact with others. Men and women become hermits for many reasons. They may want to avoid the evils or temptations they see in society. They may believe they can purify themselves by living alone. Or they may simply want nothing to do with other people.

Hermits give up comfort, family, marriage, property, and pleasure for chastity, fasting, meditation, and silence. They train themselves to eat simply, infrequently, and in small amounts. Curious people or people who want spiritual guidance or physical healing may seek them out. This attention sometimes drives hermits to even more secluded places.

Religious hermits are commonly regarded as holy persons. They have played important roles in forming the religious disciplines of Buddhism, Christianity, Hinduism, Islam, and Taoism. Religious hermits have withdrawn to caves, cells, holes, pillars, and tombs. They may live in deserts, forests, mountain ravines, or even in cities.

In some religions, particularly Buddhism and Christianity, there were hermits who came to regard solitude as selfish. They joined others in forming hermitages. In a hermitage, a number of hermits live in separate cells or rooms and follow religious disciplines. They have few social contacts. Monasteries developed from hermitages. In monastic communities, monks form self-sufficient social groups and set aside certain times for solitary meditation and prayer.

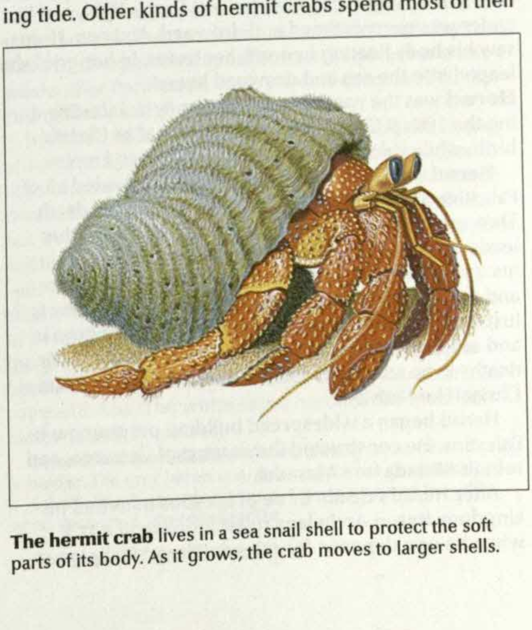
Anyone may want to be alone and silent for a time to think seriously, work, or prepare for some special event. Hermits find this experience so rewarding that it becomes a way of life for them.

See also **Asceticism; Monasticism.**

Hermit crab is an animal best known for its habit of occupying the empty shell of a snail. The crab uses the shell to protect its soft abdomen, which it twists into the shell. A pair of small modified limbs at the end of the abdomen grip the interior of the shell tightly. The other walking legs and the claws are covered with a hard, thick material called *chitin* and usually remain outside the shell. In some cases, a hermit crab can withdraw completely into the shell. It seals off the shell's opening with one or both claws.

As hermit crabs grow, they exchange their shells for larger ones. A crab usually finds an empty shell to occupy, but it will pull a snail from a shell if necessary. Hermit crabs compete with each other for empty shells in areas where the shells are scarce. Some species occupy holes in small pieces of coral, rock, or wood instead of shells.

Marine hermit crabs often crowd the ocean floor in areas where food and snail shells are abundant. They also live along the seashore in pools left by the retreating tide. Other kinds of hermit crabs spend most of their



The hermit crab lives in a sea snail shell to protect the soft parts of its body. As it grows, the crab moves to larger shells.

lives on shore. They occupy the shells of land snails. One type of land hermit crab is called the *coconut crab* or *robber crab* because it is known to feed on the meat of coconuts. Adult coconut crabs do not occupy shells. In these crabs, the abdomen is curled under the rest of the body.

Scientific classification. Hermit crabs belong to the class Crustacea and make up the hermit crab family, Paguridae.

Hermitage. See **Saint Petersburg** (Education and cultural life).

Hernia, also called *rupture,* is the protrusion of an organ or tissue through cavity walls within the body. Many organs of the body, such as the lungs, heart, or intestines, are inside hollow places called *body cavities.* Sometimes the wall of a cavity breaks, or ruptures, and part of the organ pushes through. Then the person has a hernia. When used alone, the word generally means an *inguinal hernia.* In this type of hernia, a loop of the bowel sticks out through the muscular wall of the lower abdomen. The hernia often occurs at a weak point of the muscular wall. It usually pushes out a part of the inner lining of the abdomen, the *peritoneum,* and forms a *hernial sac.* This sac may be felt or seen underneath the skin of the abdomen.

The danger of inguinal hernia is that the abdominal muscles may contract, *strangulating* (choking off) the part of the bowel that protrudes. Doctors usually operate immediately on people with this condition.

In *hernia cerebri,* a portion of the brain protrudes through an opening in the skull. Hernia may also occur in various other internal organs, such as the bladder.

Hernia results from many causes. An inguinal hernia sometimes results from lifting a heavy object, from coughing, or from a strain or other injury.

Hero. See **Invention** (Ancient Greece); **Steam engine** (History).

Hero and Leander were legendary Greek lovers. Hero was a priestess of the goddess Aphrodite at Sestos in Thrace. Leander lived at Abydos across the Hellespont, or Dardanelles. Every night, Hero put a light in her tower, and Leander swam across the water to visit her. One stormy night, the wind put out Hero's light, and Leander was overwhelmed and drowned. At dawn, Hero saw his body floating beneath her tower. In her grief she leaped into the sea and drowned herself.

Herod was the name of a ruling family in Palestine during the 100's B.C. and the first 100 years after Christ's birth, while Palestine was part of the Roman Empire.

Herod the Great (about 73-about 4 B.C.) ruled all of Palestine as king of Judea from 37 B.C. until his death. Throughout his reign, he put down plots against his leadership by killing anyone suspected of threatening his throne. The executions included three of his sons and several other family members. His ruthlessness is illustrated in the story of the slaughter of infant boys in and around Bethlehem (Matt. 2). Herod ordered their deaths in an attempt to kill the infant Jesus (see **Jesus Christ** [The Nativity]).

Herod began a widespread building programme in Palestine. He constructed the seaport of Caesarea, and rebuilt Masada (see **Masada**).

After Herod's death, three of his sons inherited his kingdom. Herod Archelaus ruled Judea until A.D. 6, when he was deposed for misrule. Herod Philip governed northeastern Palestine until his death in A.D. 34. Herod Antipas inherited Galilee and Perea.

Herod Antipas (?-A.D. 40), son of Herod the Great, governed Galilee and Perea until he was deposed in A.D. 39. Like his father, Antipas maintained his power by threats and by eliminating his enemies. Antipas arrested John the Baptist and had him beheaded (see **John the Baptist, Saint**). Antipas continued the building programme begun by Herod the Great. His greatest project was construction of a complete city, Tiberius, on the shore of the Sea of Galilee.

Herod Agrippa I (10 B.C.-A.D. 44), grandson of Herod the Great, began ruling northeastern Palestine in A.D. 37. In A.D. 39, he received Galilee and Perea, formerly the territory of Herod Antipas. Agrippa I helped Claudius become emperor of Rome in A.D. 41. In reward, Claudius added Judea and Samaria to Herod's kingdom.

Agrippa I persecuted the Christian community in Jerusalem (Acts 12). He was a harsh ruler who could angrily attack anyone who opposed him.

Herod Agrippa II (A.D. 27-100) was the son of Herod Agrippa I. He became king of Chalis, a small territory in what is now Lebanon, in A.D. 50. In A.D. 56, he received Galilee and Perea from the Roman Emperor Nero.

Agrippa II tried to prevent the Jewish revolt against Rome, but he failed. When war broke out in A.D. 66, he sided firmly with the Romans.

Herodotus (484?-425? B.C.) was the first Greek historian. He is famous for the nine books he wrote on the rise of the Persian Empire, the Persian invasions of Greece in 490 and 480 B.C., the heroic fight of the Greeks against the invaders, and the final Greek victory. Herodotus saw the wars between Persia and Greece as part of a series of struggles between Eastern monarchies and the West. Cycles of happiness and misery for states and individuals play an important part in his historical accounts. Herodotus thought that the gods used such cycles to punish human pride.

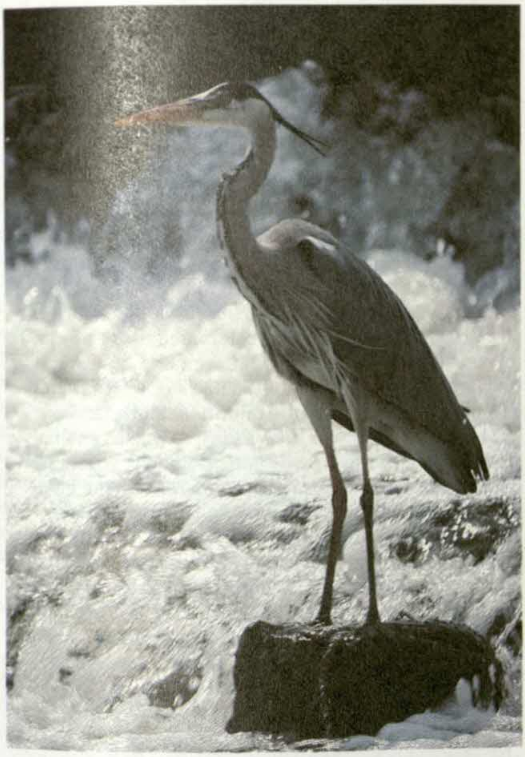
Herodotus was born at Halicarnassus, in Asia Minor (now Turkey). During his youth, he travelled widely in Greece, the Middle East, and North Africa. Everywhere he went, he studied the manners, customs, and religions of the people, and learned as much as he could of their history. Although he questioned the accuracy of many of the stories he repeated, scholars have confirmed much of his information. In about 447 B.C., Herodotus visited Athens, and three years later settled in the colony of Thurii, which Pericles was then founding in southern Italy. It has been said that Herodotus died and was buried at Thurii. For a quotation from Herodotus, see **Post office** (Ancient times).

Heroic Age. See **Age** (Golden Age).

Heroic couplet. See **English literature** (Restoration drama); **Pope, Alexander.**

Heroin is a drug made from morphine, an active chemical in opium. Like morphine, heroin relieves pain and brings sleep. But because it is stronger and more addictive than morphine, it is rarely used for medical purposes. Many governments forbid the manufacture, importation, and use of heroin, but many people obtain it illegally. Heroin has several nicknames, including "H," "horse," and "smack."

Drug addicts use heroin by *snorting* (sniffing it), by *skin popping* (injecting it under the skin), or by *mainlin-*



The grey heron is the common heron of Europe. It is found by waterways, from fast flowing streams to canals.

A purple heron makes its nest in a tree. Herons nest in colonies called *heronries.*

ing (injecting it into a vein). To addicts, heroin offers escape from a seemingly intolerable existence by providing a feeling of joy and relief. In time, the repeated use results in physical and psychological dependence on the drug. If an addict stops taking heroin, he or she suffers such withdrawal symptoms as body aches, diarrhoea, muscle cramps, or nausea. The intensity of these symptoms peaks in 2 to 3 days and then gradually decreases over 7 to 10 days. Addicts who suddenly resume taking heroin in the same amounts they took previously risk having a fatal overdose. The addict's chief goal is getting more heroin. Many addicts turn to crime—particularly theft or prostitution—to get the large amounts of money needed to buy the drug.

Many addicts do not eat nourishing foods or maintain personal cleanliness. Also, the needle used to inject the drug is often unsterile. Such neglect can result in AIDS, hepatitis, malnutrition, pneumonia, or skin infections. Babies born to mothers addicted to an opium-based drug are physically dependent on the drug and have to undergo withdrawal treatment.

Programmes offering treatment and rehabilitation for heroin addicts have been developed.

See also **Drug abuse; Morphine.**

Heron is any of about 60 species of wading birds, including egrets and bitterns. Herons are graceful birds with long, pointed bills. They have narrow heads, long slender necks, and sticklike legs. Some herons have long crests and plumes on their throats and bodies. Herons live in all the continents except Antarctica.

Habits. In flight, herons stretch their long legs straight out behind them and curl their heads between their shoulders. Cranes, storks, and ibises fly with their necks extended. Herons usually nest and roost in flocks, but they hunt food alone. Their nesting places are called *heronries.* The nests consist of loose, crude masses of sticks built in treetops or in bushes. The female lays three to six eggs. Young herons are helpless for a few weeks after they hatch. Their parents carry food to the young birds until they can fly.

In search of food, the heron wades along the shores of streams with a stately stride, silent and alone. Sometimes the bird may stand for a long time with its head drawn between its shoulders. It appears to be asleep, but it is actually patiently waiting for fish, frogs, crayfish, and other small animals which it will eat. As soon as it sees its prey, the heron makes a lightning dart and catches the victim in its spearlike bill. Common species of heron include the grey heron of the Old World and the great blue heron of the New World. The purple heron is a handsomely marked species of southern Europe and Asia. The white-faced heron is the most common Australian species.

Scientific classification. Herons belong to the heron family Ardeidae. The grey heron is *Ardea cinerea,* the great blue heron is *A. herodias,* the purple heron is *A. purpurea,* and the white-faced heron is *A. novaehollandiae.*

See also **Bittern; Crane; Egret.**

Herpes, Genital, is the name of a widespread sexually transmitted disease. It is also known simply as *herpes.* Genital herpes is caused by the *herpes simplex virus, type 1 (HSV-1)* or *type 2 (HSV-2).* HSV-1 and HSV-2 are two of the *herpesviruses,* a group of viruses that cause a wide variety of diseases. See **Herpesvirus.**

The herpes simplex virus infects only human beings and is transmitted during intimate sexual activity. In most cases, infection occurs on or around the sex organs or rectum. The virus then spreads along the nerves that connect the infected area to the central nervous system. The virus may be present in the body without producing signs of illness. An infected person also may experience symptoms that go away, only to reappear months or years later.

Symptoms include fever, headache, stiffness in the neck, and weakness. Within one to three weeks after infection, a small pimple develops at the site of infection. The pimple rapidly becomes a blister, which then develops into an open, painful sore called an *ulcer.* Other blisters appear, accompanied by painful urination and itching. Women may experience discharge from the vagina. The ulcers last 4 to 15 days, then gradually crust over and heal. Sores may recur up to several times a year. During these times, the blisters and ulcers heal more rapidly and are less painful.

In people with AIDS, symptoms of genital herpes can be particularly severe, involving persistent, painful ulcers that last for months. The symptoms worsen as AIDS progresses and become very difficult to control.

A pregnant woman who has genital herpes may pass the infection to her baby during the birth process. Infection in the newborn may spread throughout the body, leading to blindness, brain damage, or death.

Doctors usually diagnose genital herpes by recognizing symptoms of the disease. Doctors prescribe the drug acyclovir in treating the first episodes of genital herpes. In most cases, this drug reduces the severity of the symptoms. Individuals may reduce the risk of infection with genital herpes by using condoms or other protective measures during sexual activity.

See also **Sexually transmitted disease.**

Herpesvirus is the name of a group of viruses that cause a wide variety of diseases. Genital herpes, a widespread sexually transmitted disease, is caused by a herpesvirus. Herpesviruses also cause such conditions as chickenpox, cold sores, glandular fever, and shingles.

Herpesviruses may be present in the body without producing signs of illness. People infected with certain herpesviruses may experience symptoms that go away, then reappear months or years later. The viruses are spread through direct physical contact with an infected person.

Related articles in ***World Book*** include:

Chickenpox
Cold sore
Encephalitis
Epstein-Barr virus
Herpes, Genital
Meningitis
Glandular fever
Shingles

Herpetology is the branch of zoology concerned with the study of reptiles and amphibians. The name *herpetology* comes from the Greek word *herpeton,* meaning *crawling thing.* Herpetologists study such animals as snakes, lizards, crocodiles, frogs, and salamanders. Herpetologists have made important contributions to many areas of biology, including ecology, evolution, and animal behaviour.

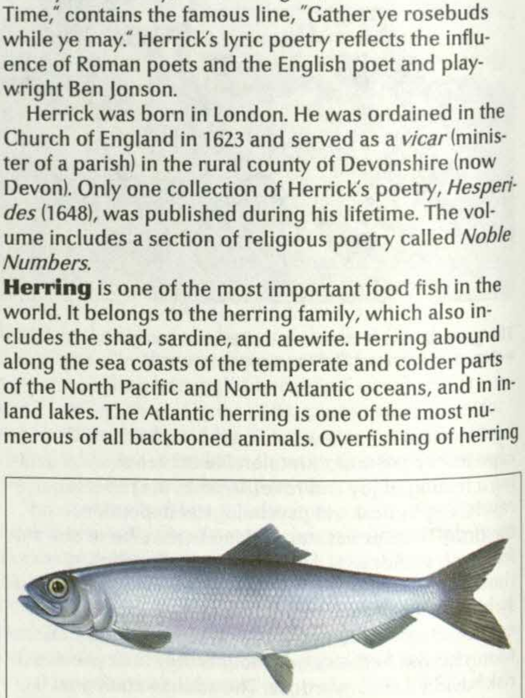
See also **Amphibian; Reptile.**

Herrera, Tomás (1804-1854), was a soldier and statesman of Panama. He led the movement in 1840 to make Panama independent of Colombia. He was president of the Free State of Panama for the year that it existed, and later held high office in Colombia. Herrera was born in Panama City. In 1854, he put down a revolt in Colombia, and was killed leading his army into Bogotá.

Herrick, Robert (1591-1674), was one of England's finest lyric poets. He is best known for his love lyrics to imaginary ladies and graceful poems about nature and English country life. Herrick celebrated the earthy joys of rural life in such poems as "Corinna's Going A-Maying," "The Argument of His Book," and "To Daffodils." His playful poem about the importance of spending one's youth wisely, "To the Virgins, to Make Much of Time," contains the famous line, "Gather ye rosebuds while ye may." Herrick's lyric poetry reflects the influence of Roman poets and the English poet and playwright Ben Jonson.

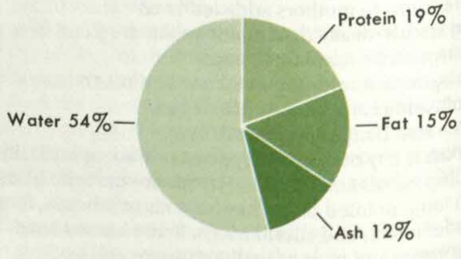
Herrick was born in London. He was ordained in the Church of England in 1623 and served as a *vicar* (minister of a parish) in the rural county of Devonshire (now Devon). Only one collection of Herrick's poetry, *Hesperides* (1648), was published during his lifetime. The volume includes a section of religious poetry called *Noble Numbers.*

Herring is one of the most important food fish in the world. It belongs to the herring family, which also includes the shad, sardine, and alewife. Herring abound along the sea coasts of the temperate and colder parts of the North Pacific and North Atlantic oceans, and in inland lakes. The Atlantic herring is one of the most numerous of all backboned animals. Overfishing of herring



Pacific herring inhabit the ocean's northern waters.

The food value of herring



in the North Sea made breeding stock decline greatly in the 1970's. To reverse the decline, several countries took steps to restrict herring fishing in North Sea waters. By the 1990's, herring stock began to increase.

Appearance and habits. Herring are well-formed fish. They have thin scales coloured blue-green to blackish above, brilliant silver on the sides, and white below. Both jaws have small teeth. Small crustaceans are the herring's chief source of food. Millions of herring swim close together near the surface of the water, in areas ranging from 15 to 50 square kilometres.

Herring spend part of the time in deep water, then migrate to shallower coastal waters where they lay their eggs. A female deposits from 20,000 to 185,000 eggs, depending on her size. The eggs settle to the bottom, where they cover seaweed and rocks. Within a few weeks, the eggs hatch. Herring have many enemies. In spite of the number of eggs which are laid, few develop into adult herring. Crabs and such fish as haddock eat many of the eggs and young. The adult herring are eaten by other marine creatures including fishes such as cod, salmon, and tuna, as well as dolphins and seabirds such as gannets.

Commercial fishing. Fishing crews find the great shoals of herring by watching for the many sea birds that hover over them and by the light, or luminescence, caused in the sea water by the swimming herring. Some boats now detect the shoals by devices similar to those used for detecting submarines during wartime.

Herring fishermen bring in a large catch of the fish from the Atlantic Ocean. Herring is one of the most important food fishes in the world.

Herring are usually caught in large nets. A fishing crew goes to a spot where a large number of herring are seen, and lets an immense net out. The crew then rows along the edges of the net in small boats, and forces the mass of fish nearer the centre. Then, the fishing boat approaches and many thousands of herring are raised in the net and thrown into the boat.

About 2.3 million metric tons of herring are caught each year. Prior to its breakup, the Soviet Union led all countries in the number of fish caught.

Uses. Many herring are frozen and used for bait in the halibut and cod fisheries. Industry makes millions into fertilizer, and uses the oil extracted from them to lubricate machinery and for other purposes.

In many parts of the world, herring are a favourite food, either pickled, smoked, or eaten fresh. Herring which have been salted in brine, smoked, and cured are known as *bloaters.* Those similarly prepared, but also split and cleaned, are called *kippers.* Small herring are often sold as *whitebait.* Pickled herring are put into brine, sometimes with onions and spices. They are sold either *round* or *split.* Round herring are salted whole. Split herring have the gills, heart, and other parts removed. Herring are a popular food especially in Scandinavian countries.

Scientific classification. Herring are members of the herring family, Clupeidae. The Atlantic herring is *Clupea harengus.* The Pacific herring is *C. pallasii.*

See also **Alewife; Fish** (picture: Fish of coastal waters and the open ocean); **Sardine; Shad.**

Herrmann, Adelaide. See **Magician** (Illusions).

Herschel is the family name of three British astronomers.

Sir William Herschel (1738-1822) founded the present-day system of star astronomy. In 1781, he discovered Uranus, the first planet discovered since prehistoric times. He found that Uranus rotated in a *retrograde* (backward) direction. Unlike most of the planets, Uranus rotates in a clockwise direction. Venus is the only other planet with this retrograde rotation. He also found two of its satellites, and saw that they revolved around Uranus in the backward direction. Herschel discovered two satellites of Saturn. He also discovered infrared radiation. He became the first astronomer to undertake a thorough review of the heavens, and contributed pioneering ideas of the stellar system's structure. Herschel was born in Hanover, Germany. He moved to England in 1757.

Caroline Lucretia Herschel (1750-1848), the sister of Sir William, was the first woman to discover a comet. She found at least five of them, as well as several nebulae and star clusters (see **Nebula**). Herschel was born in Hanover, Germany. She later joined her brother in England, where he trained her in astronomy.

Sir John Frederick William Herschel (1792-1871), the son of Sir William, surveyed the southern skies as systematically as his father had studied the northern heavens. His discovery that *sodium thiosulphate* (hypo) dissolves silver salts gave photography an improved fixing agent. He was born in Slough, Berkshire, England.

Hertfordshire is a county in southern England that is known for its fine scenery, its beautiful old houses, its new towns, and its high technology and aerospace industries. Much of Hertfordshire's agriculture is geared to the markets of London.

People and government

Recreation. Watford has a soccer team that plays in the Football League. The county cricket team plays in the minor counties league.

Local government. Hertfordshire is divided into 10 local government districts for administration. These districts are *Broxbourne,* which includes Cheshunt and Hoddesdon; *Dacorum,* which includes Berkhamsted, Hemel Hempstead, and Tring; *East Hertfordshire,* which includes Bishop's Stortford, Hertford, and Ware; *Hertsmere,* which includes Borehamwood, Bushey, Potters Bar, and Radlett; *North Hertfordshire,* which includes Baldock, Hitchin, Letchworth, and Royston; *St. Albans,* which includes Harpenden; *Stevenage; Three Rivers,* which includes Chorleywood and Rickmansworth; *Watford;* and *Welwyn Hatfield.*

Hertfordshire has several *new towns* (see **New town**). These towns are Hatfield, Hemel Hempstead, Stevenage, and Welwyn Garden City. The county has two police forces. The Hertfordshire Constabulary, based at Welwyn Garden City, polices most of the county. The Metropolitan Police operate in the south. The crown court meets at St. Albans. Hertford is the headquarters of the county council, which provides some public services throughout the county.

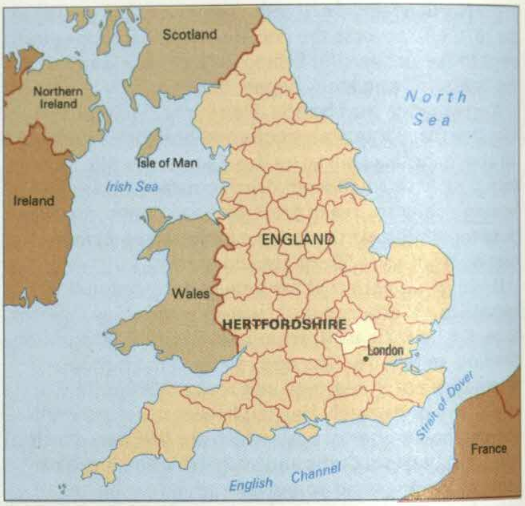
Economy

Manufacturing. The county has a wide variety of manufacturing industries, many of them attracted to the new towns in recent years. Letchworth, St. Albans, and Watford have important engineering industries. Hatfield, St. Albans, and Stevenage have aerospace and aircraft industries. Paper and printing industries are located at Hemel Hempstead, Letchworth, and Watford, and food-processing industries are at Watford and Welwyn Garden City. Pharmaceuticals manufacture and research is an important industry throughout the county, with major sites in Stevenage, Ware, Welwyn Garden City, and Hoddesdon. Hemel Hempstead, Letchworth, and Stevenage are significant centres of the computer industry.

Agriculture. Fewer than 3 per cent of employed people in Hertfordshire work in agriculture. Arable farms in the north grow crops of barley, cattle fodder, oats, and wheat, and root crops, such as potatoes and turnips. Some farmers in northern and eastern Hertfordshire grow sugar beet.

Facts in brief about Hertfordshire

Administrative centre: Hertford.
Largest towns: Watford, Stevenage, Hemel Hempstead, St. Albans, Cheshunt, Welwyn Garden City.
Area: 1,635 km^2.
Population: *1991 census*–951,500.
Chief products: *Agriculture*–barley, cucumbers, flowers, fruit, lettuces, milk, mushrooms, oats, potatoes, spinach, sugar beet, tomatoes, turnips, wheat. *Manufacturing and processing*–aircraft, chemicals, clothing, computers, foodstuffs, light-engineering products, machinery and machine tools, paper, parachutes, pharmaceuticals, scientific instruments.



Hertfordshire is a county in southeastern England. It lies to the north of London.

Harpenden has apple and cherry orchards. Kimpton, near Codicote, and Redbourn also have apple orchards. In the southeast, farmers grow cucumbers, flowers, lettuces, spinach, and tomatoes in greenhouses.

Market gardens are located at Bishop's Stortford, Hertford, Ware, and Watford, and in the Lea valley. Hertfordshire also has dairy farms that produce fresh milk for the London area. Other important agricultural products include mushrooms, watercress, and black grapes, which are grown in greenhouses. Hertfordshire also has some major agricultural research institutions. The well-known Rothamsted Experimental Station for Agricultural Research is located at Harpenden.

Transportation and communication. Most of the main routes run northward from London, including three stretches of motorway, the M1 and the A1(M) and M11. The M25 motorway runs east-west in the southern part of Hertfordshire.

Railway lines link most of Hertfordshire's main towns with London. They carry many commuters who work in London. The county has nearly 30 weekly newspapers.

Land

Location and size. Hertfordshire is bordered by Cambridgeshire and Bedfordshire to the north, Essex to the east, London to the south, and Buckinghamshire to the southwest. The longest north-south distance is about 40 kilometres, and the longest east-west distance is about 55 kilometres.

Land features. Chalk deposits occur in the East Anglian Heights in northeastern Hertfordshire and in the Chiltern Hills in western Hertfordshire. Clay covers the chalk of the East Anglian Heights.

The Hitchin-Stevenage gap is a valley about 6 kilometres wide. The gap separates the East Anglian Heights from a chalk ridge that is a continuation of the Chiltern Hills. This ridge rises to about 244 metres. About three-

Hatfield House is a fine Jacobean house. Hertfordshire has many such fine old houses. Hatfield House is open to the public, and its interesting exhibits include clothes worn by Elizabeth I.

quarters of the county lies on the southern slopes of the Chiltern Hills.

South of the East Anglian Heights lies the East Hertfordshire Plateau, which extends to the Lea valley. Another important natural region is the Vale of St. Albans which is drained by the River Colne and its tributaries.

Rivers. The River Lea rises in Bedfordshire. It flows through the towns of Hatfield, Hertford, and Ware and then turns south out of Hertfordshire and reaches the River Thames (see **Thames, River**). The Stort is a tributary of the Lea. The River Colne rises west of Hatfield and flows through the town of Watford to the Thames.

Climate. About 760 millimetres of rain fall every year on the Chiltern Hills. On lower ground in the east, the rainfall averages about 560 millimetres. The average January temperature in St. Albans is about 3° C. The average July temperature in St. Albans is about 17° C.

History

The Romans left much evidence of their rule in the area. They built roads, such as Ermine Street, Stane Street, and Watling Street. They also built the city of Verulamium near the site of present-day St. Albans, which got its name from Albanus, a Roman soldier martyred, probably in A.D. 209, because he was a Christian.

In the 800's and 900's, the Danes attacked parts of the county. In 896, Alfred the Great's army defeated the Danes in a battle that took place between Hertford and Ware. But the Danes occupied the land east of the River Lea. In 1066, William the Conqueror defeated the Saxons. He built castles at Berkhamsted and Hertford.

Many battles and skirmishes took place in Hertfordshire. The armies of King Stephen and, later, King John fought for the possession of Hertford. In 1381, John Ball, a priest and a leader of the Peasants' Revolt, was executed at St. Albans. In the Wars of the Roses (1455-1485), important battles were fought at St. Albans and Barnet.

In 1801, Hertfordshire had a population of 97,000. The population expanded slowly until industries were established in the 1900's. By 1961, the population had increased to more than 830,000, but changes to the southern boundary in an administrative reorganization led to a drop of about 45,000 in 1965.

Famous people born in Hertfordshire include Nicholas Brakespear, who became Pope Adrian IV in the 1100's, the only Englishman to become pope; the inventor Sir Henry Bessemer; the poet Thomas Campion; and the statesman Cecil Rhodes.

Related articles in ***World Book*** include:

Adrian IV
Barnet
Bessemer, Sir Henry
Bulwer-Lytton, Edward
Campion, Thomas
Hemel Hempstead
St. Albans
Watford

Hertsmere (pop. 86,100), a local government district in southern Hertfordshire, includes Borehamwood (the district's administrative centre), Bushey, Elstree, Potters

Places to visit in Hertfordshire

Following are brief descriptions of some of the interesting places to visit in Hertfordshire:

Ayot St. Lawrence, near Codicote, has on show the home of George Bernard Shaw.

Hatfield House is a fine house built in the early 1600's. Many historic objects are on show in the house, such as clothes that were worn by Queen Elizabeth I, and letters written by Mary, Queen of Scots. There is a maze in the gardens.

Hertford has many old buildings. They include a castle, dating from the 1500's, built on the site of a Norman castle.

Hoddesdon has the gatehouse and other remains of the Rye House, scene of the Rye House Plot to kill King Charles II.

Knebworth House, which dates from the 1500's, was the home of Edward Bulwer-Lytton.

St. Albans has many remains of the Roman city, Verulamium. St. Albans Cathedral was started in Norman times, using bricks from the Roman city.

Bar, and Radlett. Most of the district is a *green belt* (conservation) area. The district, which lies on the fringe of Greater London, is mainly residential. Two independent schools are in the district, Aldenham School, at the village of Aldenham, and Haberdasher's Aske, an independent school at Elstree. See also **Hertfordshire.**

Hertz is the unit used to measure the frequency of waves and vibrations. Its symbol is Hz. Waves exist in many forms. For example, human vocal cords vibrate, making sound waves, and radio transmitters send electromagnetic waves. One important fact about each wave is the number of complete *cycles* (vibrations) that occur each second. This number is the frequency of the wave. The musical note "A" has a frequency of 440 Hz or 440 cycles per second. Radio waves may have frequencies of many million hertz.

The hertz was adopted in 1960 by scientists at the General Conference on Weights and Measures. It was named after Heinrich Hertz, a German physicist.

See also **Hertz, Heinrich Rudolph; Sound** (Frequency and pitch); **Waves.**

Hertz, Gustav (1887-1975), a German physicist, shared the 1925 Nobel Prize for physics for proving the validity of Niels Bohr's theory of the atom (see **Bohr, Niels**). In 1932, Hertz developed a way of separating isotopes (see **Isotope**). Governments use his process in uranium separation plants. Hertz was born in Hamburg, Germany.

Hertz, Heinrich Rudolph (1857-1894), was a German physicist. He opened the way for the development of radio, television, and radar with his discovery of electromagnetic waves between 1886 and 1888. James Clerk Maxwell had predicted such waves in 1864 (see **Maxwell, James Clerk**). Hertz used a rapidly oscillating electric spark to produce waves of ultrahigh frequency. He showed that these waves caused electrical oscillations in a distant wire loop. He also showed that light waves and electromagnetic waves were identical (see **Electromagnetism**). Hertz was born in Hamburg, Germany.

Hertzog, Barry (1866-1942), was a South African soldier and political leader. As prime minister of South Africa from 1924 to 1939, he supported South African nationalism and loosened ties with the British Empire.

James Barry Munnik Hertzog was born in the Wellington area of Cape Province (now Western Cape). He gained a doctorate in law in Amsterdam in 1892, and three years later became a judge in the Orange Free State. During the Second Anglo-Boer War (1899-1902), he was a Boer general and led many daring raids against the British. Nevertheless he was a leader of the peace delegations which ended the war in 1902. In the Orange Free State he fought for and won the right for children to be educated in their mother tongue, Afrikaans (see **Afrikaans language**). In 1909, he was part of the national convention which led to the formation of the Union of South Africa in 1910. He was a founder member of the Afrikaans academy, and in 1914 founded the Hertzog prize for literature.

Herzberg, Gerhard (1904-), is a Canadian physicist who won the 1971 Nobel Prize for chemistry. He received the award for determining the electronic structure of molecules. Herzberg's studies play an important part in such fields of science as astrophysics, physical chemistry, and quantum mechanics.

Herzberg has devoted his career to the *spectroscopy* of atoms and molecules—that is, the observation of the radiation that atoms and molecules emit when excited. Such study reveals the structure of atoms and molecules. Herzberg has determined the structures of the molecules of many substances.

Herzberg was born in Hamburg, Germany, and graduated from the Darmstadt Institute of Technology in 1928. He moved to Canada in 1935 and became a Canadian citizen in 1945. In 1955, Herzberg became the director of the Division of Pure Physics of the National Research Council of Canada.

Herzegovina. See **Bosnia-Herzegovina.**

Herzen, Alexander Ivanovich (1812-1870), was a Russian journalist and one of the best-known revolutionaries of his day. He published the newspaper *Kolokol (The Bell)* in London from 1857 to 1867. The newspaper criticized the Russian government, and Herzen's writings influenced such reforms as freeing the serfs. Although officially banned in Russia, Russians read it to learn about conditions in their own country.

Herzen was born in Moscow and was educated at Moscow State University. He was exiled to Siberia in 1834 for antigovernment activities. Herzen left Russia in 1847 and never returned. He settled in London in 1852. His works include *From the Other Shore* (1850), a collection of articles; and *My Past and Thoughts* (1852-1855), a six-volume autobiography.

Herzl, Theodor (1860-1904), was an Austrian journalist and playwright who founded the Zionist movement. The movement's aim was to set up a Jewish national home in Palestine (see **Zionism**). Herzl was born in Budapest, Hungary.

The growing problem of anti-Jewish feeling in Europe, increased by the Dreyfus case in France, attracted Herzl's attention (see **Dreyfus, Alfred**). He saw that European Jews had failed to gain social equality even when they had become politically free. So Herzl got the idea of gathering the scattered Jews into a country and a nation of their own. His motives were economic and social, rather than religious. Herzl's *Jewish State,* published in 1896, attracted many people to the Zionist cause.

In 1897, Herzl presided over the first Zionist congress in Basel, Switzerland. In 1901, the United Kingdom offered the Jewish people land in British East Africa. Worry about this disputed offer hastened Herzl's death.

Herzog, Émile. See **Maurois, André.**

Heseltine, Michael Ray Dibdin (1933-), became the United Kingdom's deputy prime minister in 1995. A Conservative member of Parliament, Heseltine had challenged Prime Minister Margaret Thatcher for the leadership of the party in 1990. When it was clear that she could not win, she resigned and John Major was later elected leader. Under Thatcher, Heseltine had been secretary of state for defence from 1983 until he resigned in 1986. Under Major, Heseltine was secretary of state for the environment from 1990 to 1992, and president of the board of trade from 1992 to 1995.

Heseltine was born in Swansea, Wales, and educated at Shrewsbury School and at Oxford. He entered politics from publishing.

Heseltine, Philip. See **Warlock, Peter.**

Hesiod was a Greek epic poet who probably lived during the 700's B.C. Scholars attribute two major poems, the *Theogony* and the *Works and Days,* to Hesiod. The

Theogony combines traditional tales and Hesiod's ideas about the creation of the world, the succession of divine rulers, and the genealogy of the Greek gods. This poem is one of the earliest sources of information about Greek religion. For a discussion of the *Theogony,* see **Mythology** (Comparing myths; Greek mythology).

In the *Works and Days,* Hesiod examined human life and set forth his moral values. He addressed the poem to his brother, Perses. The *Works and Days* explains that life is difficult and people must work hard in spite of the just rule of Zeus, the king of the gods. The poem then tells the story of Pandora (see **Pandora**). The *Works and Days* also contains agricultural and moral advice to help people maintain a harmonious relationship with the gods. According to tradition, Hesiod was a farmer in Boeotia, a district of ancient Greece.

Hesperides, in Greek mythology, were the daughters of Hesperis (Evening) and Atlas, a member of a race of gods called *Titans.* The Hesperides were nymphs who lived at the western end of the world. There they guarded the golden apples that Gaea (Earth) had given to the goddess Hera when Hera married Zeus, king of the gods. A sleepless dragon helped the Hesperides guard the apples. As one of his 12 labours, the hero Hercules had to steal these apples (see **Hercules**).

Hesperornis was a bird that lived during the Upper Cretaceous period. It was about 1.8 metres tall. It had a long body and neck, a long bill with teeth, and webbed feet. It could not fly. It was an excellent diver and swimmer. Skeletons of these birds have been found in England and in the United States. See also **Bird.**

Hess, Dame Myra (1890-1965), an English concert pianist, won fame for her playing of works by classical composers, such as Scarlatti, J. S. Bach, and Mozart. In 1941, King George VI made her a Dame Commander of the Order of the British Empire for the midday concerts she played at the National Gallery during the air raids of World War II (1939-1945).

Myra Hess was born in Hampstead, north London. At the age of 12 she won a scholarship to the Royal Academy of Music. She made her debut as a soloist in 1907.

Hess, Rudolf (1894-1987), served as secretary and deputy to Adolf Hitler. In May 1941, he piloted a plane to Scotland to persuade the United Kingdom (UK) to get out of World War II (1939-1945). Hitler denied knowledge of Hess's plan. Hess was imprisoned in the UK during the war. In 1945, he was returned to Germany and, at Nuremberg, was sentenced to life imprisonment for war crimes. Hess was born in Alexandria, Egypt.

Rudolf Hess

Hesse, officially Hessen, became a state of the German Federal Republic (West Germany) in 1949. Hesse lies in west-central Germany. It was formed in 1945, during the American military occupation after World War II, by combining the former state of Hesse, also called Hesse-Darmstadt, and parts of the former Prussian provinces of Hesse-Kassel and Hesse-Nassau. Hesse covers 21,113 square kilometres, and has a population of 5,548,700.

Barley, oats, potatoes, and wheat are the chief farm products of the state. The chief minerals are coal and iron. The principal towns are Darmstadt, Frankfurt am Main, Kassel, and Wiesbaden, which is the state capital.

See also **Frankfurt; Germany; Hessians; Wiesbaden.**

Hesse, Hermann (1877-1962), a German novelist and poet, won the 1946 Nobel Prize for literature. Hesse's view of life was influenced by the German romantic writers and the Hindu philosophy of India. His novels concern the spiritual loneliness of people in a mechanized urban society, the conflict between intellect and sensuality, and the problems of people outside society, such as artists and vagabonds. The stories express a yearning for a synthesis between human sensual and intellectual capacities.

Hesse's best-known fiction includes *Knulp* (1915), *Demian* (1919), *Siddhartha* (1922), *Steppenwolf* (1927), *Narcissus and Goldmund* (1930, also called *Death and the Lover*), and *Magister Ludi* (1943, also called *The Glass Bead Game*). Hesse's simple, melodious poetry shows his love of nature. Like some of his novels, his poems tend to be self-conscious and sentimental.

Hesse was born in Calw in the Black Forest. He settled in Switzerland in 1919, and became a Swiss citizen in 1923.

Hessian fly is a tiny, two-winged insect. It is called *Hessian fly* because people once believed that it was brought to America in the straw bedding of Hessian troops during the American Revolution (1775-1783). It probably came from southern Russia. It is now found in Africa, parts of Europe and New Zealand, and wheat-growing areas of the United States and southern Canada. It is a major pest only in North America. The *larva* (maggot) attacks wheat crops. In some years, it has destroyed 10 per cent of the wheat crop. For methods of control, see **Wheat** (Controlling insect pests).

The adult Hessian fly is about 3 millimetres long, with a dark brown body and dusky grey wings. Two generations of adults are produced each year—one in the spring and one in autumn. The female lays from 250 to 300 tiny, pale-red eggs. She deposits them on a wheat leaf or stalk. In about five days, whitish maggots hatch and crawl down between the leaf sheath and the stem. They suck juice from the stem.

Scientific classification. The Hessian fly belongs to the gall midge family, Cecidomyiidae. It is *Mayetiola destructor.*

Hessians were German soldiers hired by the British to fight the colonists during the American Revolution. About 30,000 Hessians fought in the war. They were called *Hessians* because many came from Hesse-Kassel (now Hesse, in central Germany). The Hessians were victims of a European system by which governments sold men into military service. Princes who sold their services pocketed a bonus from the British government.

The Hessians were not particularly interested in the war, but they were well trained and fought well. Their performance in the battles of Long Island, Fort Washington, Brandywine, Newport, and Charleston caused the American troops to know and respect their fighting ability. The defeat of the Hessians at Trenton on December 26, 1776, boosted American morale. Some Hessians were won over to the American cause and deserted the

Detail from *Capture of the Hessians at Trenton* (about 1790), an oil painting by John Trumbull: Yale University Art Gallery, New Haven, Connecticut, U.S.A.

The surrender of the Hessians after the Battle of Trenton on Dec. 26, 1776, raised the spirits of the American troops during the American Revolution. About 1,000 Hessians were captured.

British army. Many remained in the United States after the war.

Hestia was the Greek goddess of the hearth and its fire. The hearth served as the centre of family life, and fire also had a vital role in ancient Greece. As a result, Hestia ranked as one of the most important goddesses. The Greeks worshipped her as a protector not only of the home, but also of the city and state.

According to Greek mythology, Hestia was the first child of Cronus and Rhea. Thus, she was one of the most beloved of the goddesses who lived on Mount Olympus. The Greeks called on her first in their prayers and offered her the richest share of their sacrifices. They believed that Zeus, king of the gods, granted her these honours after she vowed to remain a virgin. Hestia resembled the Roman goddess Vesta, who was served by priestesses called Vestal Virgins.

See also **Vesta.**

Heston and Isleworth. See **Hounslow.**

Heteronym is a word which has the same spelling as another word or words but with a completely different pronunciation and meaning. For example, the word *tear,* when pronounced *tair,* means to pull apart. But when it is pronounced *tihr,* it means a drop of salty liquid that comes out of the eye.

See also **Homonym.**

Heterotropia. See **Strabismus.**

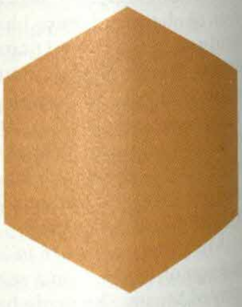
Hevesy, Georg von (1885-1966), won the 1943 Nobel Prize for chemistry. He received the award primarily for his research work on the use of isotopes as indicators in the study of chemical processes (see **Isotope**). In addition, Hevesy helped discover the element hafnium, which is found in zircon ore (see **Hafnium**).

Hevesy was born in Budapest, Hungary, but he later moved to Denmark. Hevesy conducted his research work at the Institute for Theoretical Physics in Copenhagen.

Hewson, John (1946-   ), was leader of the Australian Liberal Party from 1990 to 1994. Hewson entered parliament as member for Wentworth, New South Wales, in 1987. He served as *shadow* (opposition) minister for finance and was elected as shadow treasurer in 1989.

John Robert Hewson was born in Carlton, New South Wales. He graduated from Sydney University and studied at the University of Saskatchewan, Canada. He gained a PhD from Johns Hopkins University, Washington D.C. Hewson was professor of economics at the University of New South Wales from 1978 to 1987.

Hexagon is a plane figure that has six sides. It is a type of polygon. The sides of a hexagon meet at points called *vertices,* forming six interior angles. The sum of a hexagon's interior angles is always 720°. A hexagon is said to be *regular* if all its sides and angles are equal. Each angle of a regular hexagon measures 120°. The area of a regular hexagon equals one-half the product of its perimeter and its *apothem,* which is the distance from the centre of a regular polygon to the midpoint of one of its sides.



A regular hexagon, *above,* has six sides of equal length.

Hexahedron, in geometry, is a solid figure that has six faces. It is a kind of *polyhedron,* which is a solid whose faces are polygons (see **Polygon**). A familiar hexahedron is the cube. See also **Cube.**

Hexameter. See **Metre** (poetry).

Heydrich, Reinhard (1904-1942), called the *Hangman,* was one of the most feared men in Nazi Germany. As chief of the security police, he was responsible for killing hundreds of hostages. He was killed by a bomb in Czechoslovakia in 1942. In revenge, the Nazis killed more than 300 Czechs and destroyed the town of Lidice. Heydrich was born in Halle, Germany.

Heyer, Georgette (1902-1974), a prolific English novelist, became well-known for her light romantic novels set in the early 1800's. These novels contain detailed descriptions of the clothes, customs, and manners of the Regency period. Examples are *The Regency Buck* (1935), *Bath Tangle* (1955), and *Frederica* (1965). She also wrote such detective novels as *Death in the Stocks* (1935) and *Detection Unlimited* (1953).

Georgette Heyer was born and educated in Wimbledon, south London. She finished her first novel, *The Black Moth,* when she was only 17.

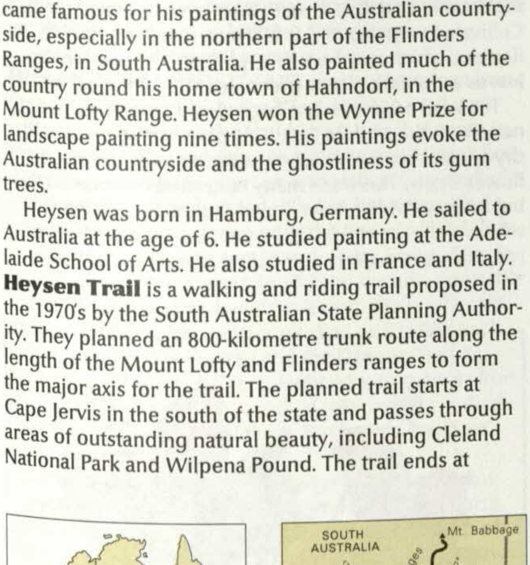
Heyerdahl, Thor (1914-), is a Norwegian anthropologist and author. He won fame in 1947 by sailing a balsa-wood raft named *Kon-Tiki* from Peru to the Tuamotu Islands in eastern Polynesia. He and five companions made the trip to test his theory that the islands of Polynesia could have been settled by Indians from South America. His book, *Kon-Tiki* (1950), tells the story of the voyage. In 1958, he wrote *Aku-Aku,* a book about Easter Island. In 1970, Heyerdahl and a crew of seven sailed a papyrus reed boat named *Ra-2* from Morocco to Barbados in the West Indies. He claimed that this voyage proved that the ancient Egyptians could have sailed similar boats to the New World. Heyerdahl was born in Larvik, Norway. See also **Raft** (picture: Rafts).

Thor Heyerdahl

Heysen, Sir Hans (1877-1968), an Australian artist, became famous for his paintings of the Australian countryside, especially in the northern part of the Flinders Ranges, in South Australia. He also painted much of the country round his home town of Hahndorf, in the Mount Lofty Range. Heysen won the Wynne Prize for landscape painting nine times. His paintings evoke the Australian countryside and the ghostliness of its gum trees.

Heysen was born in Hamburg, Germany. He sailed to Australia at the age of 6. He studied painting at the Adelaide School of Arts. He also studied in France and Italy.

Heysen Trail is a walking and riding trail proposed in the 1970's by the South Australian State Planning Authority. They planned an 800-kilometre trunk route along the length of the Mount Lofty and Flinders ranges to form the major axis for the trail. The planned trail starts at Cape Jervis in the south of the state and passes through areas of outstanding natural beauty, including Cleland National Park and Wilpena Pound. The trail ends at Mount Babbage, in the northern extremity of the Flinders Ranges.



The Heysen Trail extends through the Mount Lofty and the Flinders ranges. The trail passes many scenic areas.

Heywood, Thomas (1574?-1641), was a popular and productive English playwright of the Elizabethan Age. He claimed he wrote all or part of 220 plays, of which about 20 survive. His most enduring drama is *A Woman Killed with Kindness* (1603). This tragedy is almost unique in Elizabethan drama because the characters in the play are not of high rank, and its central situation is wholly domestic and free from political overtones. The play thus anticipates the direction that serious drama took almost 300 years later in the works of Henrik Ibsen.

Heywood's other plays include *Edward IV* (1599), *The Fair Maid of the West* (1610?), and adaptations of classical myths. He also produced translations and pamphlets. His most important pamphlet was *An Apology for Actors* (1612), a reply to Puritan attacks on the theatre. Heywood was born in Lincolnshire.

Hezekiah was the king of Judah from about 727 to 698 B.C. His name means "God strengthens" in Hebrew. During Hezekiah's reign, Judah was caught between the two major powers of Assyria and Egypt. Encouraged by the prophet Isaiah, Hezekiah resisted the mighty Assyrian army led by Sennacherib (see **Isaiah, Book of**). As a result, the Assyrians besieged Jerusalem in 701 B.C., but a plague struck them and forced them to withdraw. This story is told in the Bible in II Kings 18-19 and Isaiah 36-37.

Hezekiah is said to have "trusted in the Lord the god of Israel; so that there was none like him among all the kings of Judah . . ." (II Kings 18:5). This passage praised Hezekiah's attempts to reform religion in Jerusalem, and to rid Judah of idolatry. In the New Testament, Hezekiah is listed in the genealogy of Jesus Christ (Matt. 1:9-10).

Hi-fi. See **High fidelity system.**

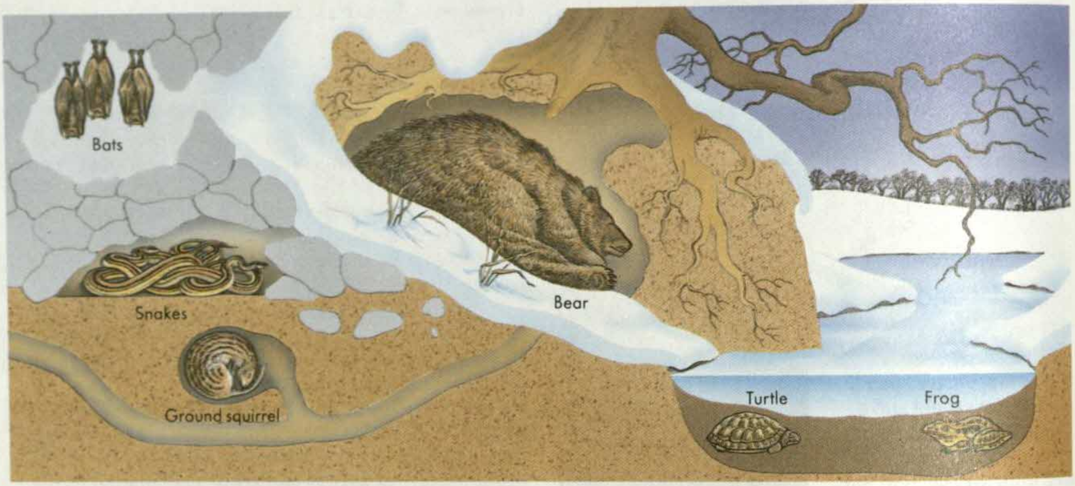
Hiawatha. See **Song of Hiawatha.**

Hibernation is an inactive, sleeplike state that some animals enter during the winter. Animals that hibernate protect themselves against the cold and reduce their need for food. A hibernating animal's body temperature is lower than normal, and its heartbeat and breathing slow down greatly. An animal in this state needs little energy to stay alive and can live off fat stored in its body. Thus, hibernating animals can more easily survive cold winters when food is scarce.

Warm-blooded hibernators include such birds as swifts; and such mammals as bats, squirrels, hamsters, hedgehogs, and marmots. Most of these animals eat large amounts of food in the autumn. The food is stored in the animals' bodies as fat, which provides energy during hibernation. Hibernating birds and mammals do not sleep straight through the winter. Instead, these animals experience several *bouts*—periods of deep hibernation—that alternate with periods of wakefulness. They are able to arouse themselves from hibernation at any time and may also be aroused by heat. A few hibernators store food in their caves or burrows. They eat this food between bouts.

Some bears experience a period of *dormancy* (inactivity) during the winter that is characterized by a prolonged sleep. Scientists disagree on whether or not this winter sleep is true hibernation. Many scientists do not classify bears as hibernators because a bear's body temperature falls only slightly during dormancy. They also

Animals that sleep through the winter



point out that bears are easily aroused from their winter sleep. Many other scientists, however, believe that bears are true hibernators. They argue that a bear's heart rate drops to less than half of normal during winter sleep. These scientists think that bears have a high body temperature when dormant because their large bodies do not lose as much heat as do the small bodies of other hibernators.

Cold-blooded hibernators include such amphibians as frogs and toads; and such reptiles as lizards, snakes, and turtles. The body temperature of these animals rises and falls with the temperature of the environment. When cold weather causes their body temperature to drop, the animals enter hibernation. An amphibian or reptile can only be aroused from hibernation when its environment warms up enough to heat its body.

Other kinds of dormancy. Some species of bats are dormant each day and active each night. Some birds, such as hummingbirds, are active during the day and dormant at night. These types of dormancy are known as *diurnal torpidity.* Some animals become dormant in the summer to protect themselves from heat and drought. This type of dormancy is called *aestivation.* Many insects experience *diapause,* a period of inactivity and lack of growth. Diapause can occur in any season. When it occurs during the winter, it is sometimes called hibernation.

Related articles in ***World Book*** include:

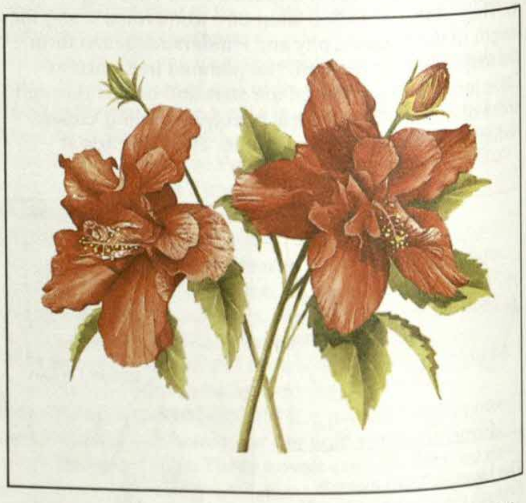
Aestivation
Bat (Hibernation and migration)
Bear (Winter sleep)
Butterfly (Hibernation)
Insect (Hibernation and migration)
Snake (Regulation of body temperature)
Turtle (Hibernation)

Hibernia is an old name for Ireland. It comes from the Latin *Juverna,* which scholars believe to be the name Julius Caesar gave the country. Many uses of the name can be found in the Latin classics, especially in the writings of the Greek geographer Ptolemy, who described Ireland in detail.

Hibiscus is the name of a group of plants that belong to the mallow family. There are about 300 species of hibiscus, including annuals, evergreens, and deciduous shrubs. Many are grown as ornamental plants for their large, colourful flowers.

A popular species is the tropical *Chinese hibiscus* which in cultivation grows to about 2 metres high. It has large bell-shaped flowers. The Chinese sometimes use the flowers as a dye, to stain their eyebrows and teeth. Cultivated varieties of this hibiscus may have double flowers, which may be white, pink or lavender. The leaves are a dark glossy green, toothed at the edges.

The *rose of Sharon* is a large deciduous shrub, originally from the Middle East. This plant can tolerate cold, dry winters but needs warm summer temperatures to flower freely. There are many cultivated varieties including ones with blue flowers and others that are white with crimson centres. Wild types range from white to red and purple. *Okra,* also called *Bhindi,* or *Ladies fin-*



The Chinese hibiscus *(above)* is a tropical plant that is grown as a house plant in temperate regions.

gers), is a summer annual hibiscus of the vegetable garden. Its sticky pods are used in soups, stews, and vegetable curries. Other kinds of hibiscus are grown for their fibre.

Scientific classification. Hibiscus belong to the mallow family, Malvaceae. They make up the genus *Hibiscus.* The Chinese hibiscus is *H. rosa-sinensis* and the rose of Sharon is *H. syriacus.* Okra is *H. esculentus.*

See also **Flower** (picture: The structure of a hibiscus); **Mallow; Okra.**

Hiccup, also spelled *hiccough,* is an abrupt, involuntary intake of air caused by a spasm of the diaphragm. The *diaphragm* is a large, powerful, dome-shaped muscle that lies at the base of the chest cavity. It contracts and relaxes to draw air in and out of the lungs. Normally, these contractions are rhythmic and gentle. But irritation of organs near the diaphragm, or, sometimes, certain diseases, may cause the diaphragm to contract suddenly. This spasm pulls air into the lungs through the *larynx* (voice box). The larynx is flanked by the vocal cords and topped by the *epiglottis,* a movable cap that keeps food from getting into the air passages. The epiglottis closes over the larynx when the diaphragm suddenly contracts. When the spasm of the diaphragm pulls air into the larynx, the air forcibly strikes the closed epiglottis and causes a movement of the vocal cords. These actions result in the *hic* sound that we hear.

The hiccup may occur several times in a minute. The attack itself may last for several hours, or, rarely, for several days. People can sometimes stop hiccups by breathing deeply, drinking, or holding their breath.

See also **Diaphragm; Larynx.**

Hickok, Wild Bill (1837-1876), was an American frontier scout and marshal in the West. He was a tall man with a droopy moustache and brown hair that came to his shoulders. He won fame as a marksman. Hickok had a reputation for great courage and skill and controlled frontier outlaws single-handedly. But he never killed a man except in self-defence or in the line of official duty.

James Butler Hickok was born in Troy Grove, Illinois. In 1855, he went to Kansas. In 1858 he became constable in Monticello. In 1859, he left as a teamster in a freight caravan for Santa Fe. He later worked as a stagecoach driver on the Santa Fe Trail and the Oregon Trail. In 1861, he went to Rock Creek, Nebraska, to recover from an attack by a bear. He quarrelled with settlers in Rock Creek, and killed three of them. But he was freed on grounds of self-defence.

Later in 1861, Hickok took charge of a government wagon train carrying supplies from Fort Leavenworth, Kansas, to Sedalia, Missouri. During the remainder of the Civil War, he served as a scout in the Union Army and as a guerrilla fighter. After he returned to Kansas, he fought against the Indians and scouted for Lieutenant Colonel George A. Custer (see **Custer, George A.**).

In 1869, Hickok was marshal of the rowdy frontier town of Hays City, Kansas, later called Hays. For most of 1871, he served as marshal of the cattle town of Abilene, Kansas. There he killed a gambler, and, by mistake, a special policeman. Hickok later had a term as marshal at Hays City. In 1872, he toured the Eastern United States with the troupe of Buffalo Bill (see **Buffalo Bill**). He was shot to death in a saloon in Deadwood in the Dakota Territory. He was buried in a cemetery there.

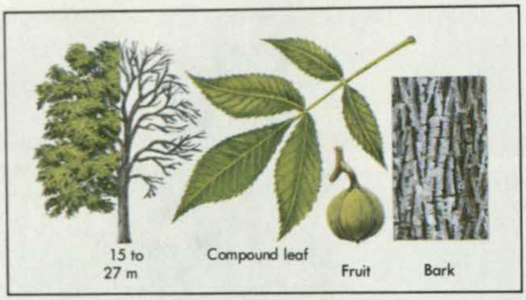
Wild Bill Hickok was an American frontier scout and peace officer in the West. He served as a scout for the Union Army during the Civil War (1861-1865) and later was a marshal in Kansas.

Hickory is any one of a group of about 15 tree species. All are confined to eastern and central North America and Mexico except two, which grow in eastern Asia. Hickories are related to walnuts and some species are known for their edible nuts. They are also valuable for their hard wood and as shade trees. The name hickory comes from *pocohicora,* an Indian word for a drink prepared from the crushed nuts.

Hickories are medium to large trees. They grow very slowly. Their leaves are made up of 5 to 17 pointed and finely toothed leaflets. Their fruit is the round, hard-shelled hickory nut. It grows in a husk that splits into four parts. *Pecans* are the most important hickory nuts. Improved varieties of pecan trees are planted for their large, oblong, thin-shelled nuts. *Bitternut hickory* and *water hickory* have bitter nuts. *Shagbark hickory* has rough, shaggy bark that splits off into long, curved strips. *Shellbark hickory* has rough bark that separates into long, straight plates. Both trees bear large, thick-shelled nuts.

Mockernut hickory is the most abundant of the hickories in the southern U.S.A. and is the only one that grows in the southern coastal pine belt. The closegrained, light brown to creamy white wood of the *pignut hickory* is hard and tough. This tree is the heaviest commercial hickory, weighing about 850 kilograms per cubic metre when air-dried.

Manufacturers value hickory wood because it combines strength, toughness, hardness, and stiffness. It is the world's foremost wood for tool handles. Manufacturers use hickory wood especially for hammers, axes,



The pignut hickory is one of the most common hickory trees. Its tough, hard wood is used to make handles for hammers, axes, picks, and other tools.

hatchets, picks, and sledgehammers. At one time vehicle makers used hickory wood to make wooden spokes for wagon wheels.

Hickory is also an excellent fuel wood because it produces much heat. It also yields a high quality of charcoal. It is often used for smoking meats. Bacon and ham have a good flavour when they are cured in hickory smoke.

Scientific classification. The hickories belong to the walnut family, Juglandaceae. Shagbark hickory is *Carya ovata.* Shellbark hickory is *C. laciniosa.* Mockernut hickory is *C. tomentosa.* Pignut hickory is *C. glabra.* Water hickory is *C. aquatica.*

See also **Bitternut; Pecan; Walnut; Wood** (picture: Some types of wood).

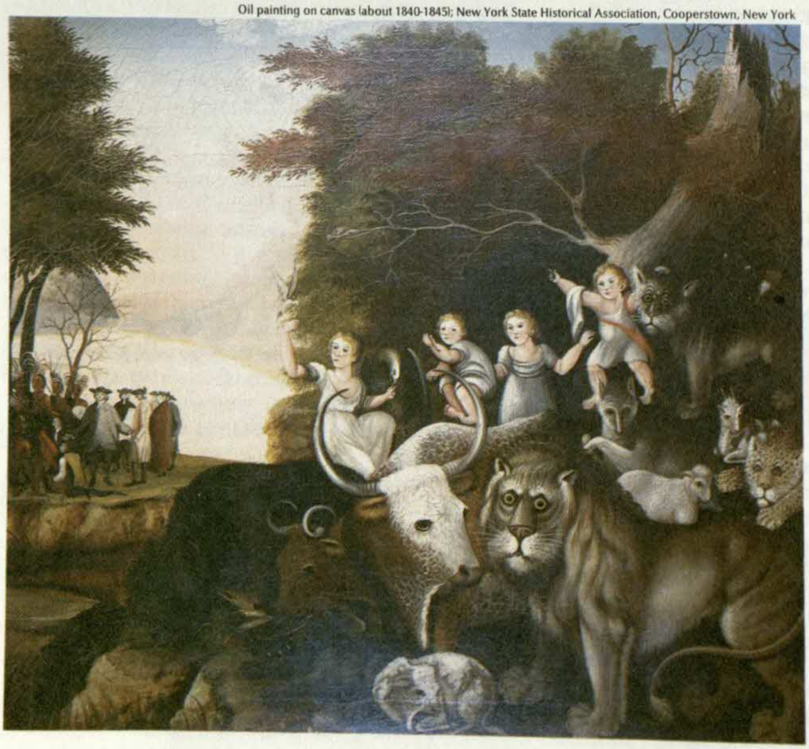
Hicks, Edward (1780-1849), was an untrained American folk painter whose works reflect his Quaker religious beliefs. Hicks is best known for more than 60 versions of a subject called *The Peaceable Kingdom* he painted beginning in 1820. Hicks based these works on an Old Testament prophecy. In God's peaceable kingdom, the lion would lie down with the lamb and a little child would lead all creatures. Quakers believed that salvation lay in the "peaceable kingdom" of a serene and well-ordered heart. Hicks visualized this belief in spiritual landscapes crowded with animals that symbolize human vices and virtues. Hicks also painted patriotic historical themes and rural scenes.

Hicks was born in Attleborough (now Langhorne), Pennsylvania. He became an unpaid, wandering Quaker minister at the age of about 22. Hicks developed his extraordinary sense of design while apprenticed to a carriage maker. He learned to decorate carriages and paint tavern signs in bold, flat colours with strong outlines. These were the characteristics that dominated his painting style.

Hicks, Sir John Richard (1904-1989), an English economist and taxation expert, gained great influence through his economic writings and teaching. Among his books are *Value and Capital* (1939), *The Problem of Budgetary Reform* (1948), *A Contribution to the Theory of the Trade Cycle* (1950), and *A Revision of Demand Theory* (1956). Hicks was born in Warwick. In 1951, he was appointed a member of the Royal Commission on the Taxation of Profits and Income. Hicks became a fellow of All Souls College, Oxford, in 1952. He shared the 1972 Nobel Prize for economics with Kenneth J. Arrow, an American.

Hicks, Zachary (1738-1771), a lieutenant on James Cook's *Endeavour,* was the first European to sight the Australian eastern coast. At sunrise on April 20, 1770,

Oil painting on canvas (about 1840-1845); New York State Historical Association, Cooperstown, New York



A Hicks painting called *The Peaceable Kingdom, left,* is based on an Old Testament prophecy. The prophecy proclaims that in God's kingdom, the lion would lie down with the lamb and a little child would lead all creatures. The background shows the American colonial leader William Penn signing a treaty with the Indians. Hicks painted dozens of versions of this subject.

Lopez Memorial Museum, Manila, Philippines

Hidalgo's *Bois de Boulogne* is an example of the dreamlike quality of his work. His use of colour and a misty light gives the scene a mood of unreality and mystery.

Hicks called out that land lay ahead. Today, the place that Cook named Point Hicks cannot be identified with certainty. But historians assume that it was the promontory later called Cape Everard, the most easterly point of Victoria. A stone obelisk there commemorates the sighting. In 1970, it was renamed Point Hicks. Hicks died at sea before the *Endeavour* reached England.

Hidalgo, Felix (1853-1913), a Filipino painter, won many prizes in Europe for his work. His canvas, *The Christian Virgins Exposed to the Populace,* won a silver medal at the National Exposition of Fine Arts in Madrid in 1884. Another painting *La Barca de Aqueronte* (The Ship of Aqueronte), won gold medals at exhibitions in Madrid in 1887 and 1892, and a silver medal in Paris in 1889.

Although much of Hidalgo's work was in the academic tradition, he also painted in the romantic vein. His paintings include landscapes and portraits of women. Many of his works have a sad and dreamlike character.

Felix Resurrection Hidalgo was born in Manila. He studied in Manila at the University of Santo Tomas. His early paintings were exhibited in the United States at the Philadelphia Exposition of 1879. In 1879, Hidalgo went to Spain and continued his studies at the Royal Academy of Fine Arts in Madrid. He lived in Paris for most of the rest of his life. He died in Barcelona in March 1913.

Hidalgo y Costilla, Miguel (1753-1811), a Mexican priest, is called "The Father of Mexican Independence." He led his Indian followers in a revolt against their Spanish rulers. He did not live to see Mexico free from Spain, but his country still honours him.

On Sept. 15, 1810, Hidalgo rang the bells of his church in the little village of Dolores. The church bells were still ringing as Hidalgo shouted the famous *Grito de Dolores* (cry of Dolores), in which he demanded independence.

Hidalgo called on his people to drive out the foreign rulers, and led his untrained soldiers against Spanish troops. For a short time, Hidalgo's forces were successful, but they could not stand up against the well-trained and well-equipped Spaniards. A year later his revolt ended when the Spaniards captured Hidalgo and put him to death.

Mexico now celebrates September 16 as Independence Day. Each year on September 15, the president of Mexico rings a bell in Mexico City and repeats the *Grito de Dolores.* Most Mexican towns have a Hidalgo monument or a Sixteenth of September street.

Hidalgo was born in Guanajuato, and was educated in Valladolid (now Morelia) and Mexico City. In 1803, he went to the parish of Dolores. There, he introduced silk manufacturing, brick-making, vineyards, and other industries which would improve the living conditions of the Mexican *peons* (labourers).

See also **Mexico** (Revolt against the Spaniards).

Hide. See **Leather.**

Hides, Jack (1906-1939), an Australian patrol officer, made many important discoveries in the rugged interior of New Guinea. He published four books on the area. In 1931, he led a patrol from Kerema, on the Gulf of Papua, toward Wau. In 1935, Hides explored the country between the Strickland and Kikori rivers. In 1938, he explored the Strickland River area in search of gold. John Gordon Hides was born at Port Moresby.

Hideyoshi (1536-1598) was a Japanese military and political leader. He ruled Japan from 1585 until his death and helped unite the country after civil war had divided it. Many Japanese regard him as a folk hero because he was a peasant who became a great leader.

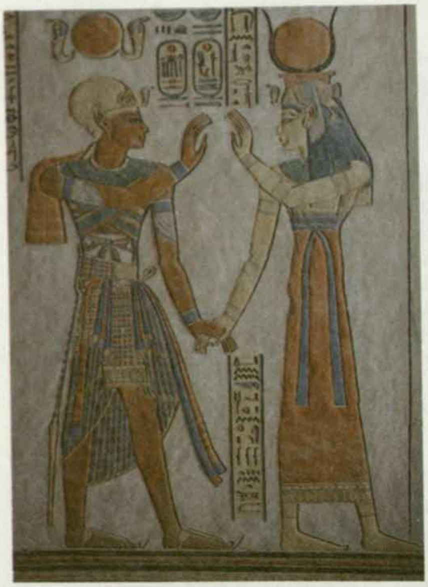
Hideyoshi was born in what is now Aichi Prefecture. His full name was Toyotomi Hideyoshi. He joined the army and gained fame and power through his remarkable military achievements. As ruler, he helped unite Japan by forming alliances with his powerful enemies and by defeating his weak enemies in battle. To prevent rebellions, he reduced the number of armed family forts, allowed only soldiers to carry weapons, and kept close check on the people. Hideyoshi tried to conquer Korea in 1592 and 1597 in unsuccessful attempts to expand Japan's territory.

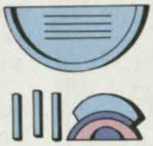
Hieratic writing. See **Hieroglyphics.**

Hieroglyphics is a form of writing in which picture symbols are used to represent ideas and sounds. The word *hieroglyphics* comes from two Greek words that mean *sacred carving.* Hieroglyphics most often refers to the writing used in ancient Egypt. However, forms of picture writing were also used in other ancient cultures, notably by the Hittites, who lived in what is now Turkey, and by the Maya and Aztec Indians who lived in Central America.

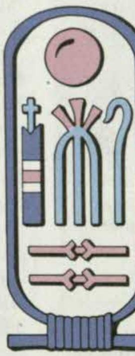
The ancient Egyptians used hieroglyphic writing for more than 3,000 years. They used such writing mainly for religious inscriptions on temples and stone monuments and to record the words and deeds of royalty. In fact, the Egyptians sometimes called their writing *the words of God.* The inscriptions were written or carved by highly trained men called *scribes.* After the A.D. 300's, the Egyptians replaced hieroglyphic writing with a simpler alphabet, and knowledge of these symbols was soon lost. The meaning of hieroglyphics remained a mystery until the early 1800's, when scholars deciphered the writing.

Development of hieroglyphic writing. The ancient Egyptians borrowed the idea of hieroglyphic writing from Mesopotamia about 3000 B.C. Egyptian hieroglyphics eventually included about 700 symbols. The symbols have the elegant, stiff quality typical of ancient Egyptian art.





The symbols on the left mean *Lord of Crowns.* The top symbol is a basket, which stands for *Lord.* Beneath the basket is a crown. The three lines to the left of the crown represent a plural.



The illustration on the left is a *cartouche* of the pharaoh Ramses III. A cartouche is an oval frame that contains the name of a ruler. The translation of this cartouche is *Ramses, Ruler of Heliopolis.* The circle at the top represents the sun god Ra. Beneath the circle on the left is a pillar that stands for the city of Heliopolis. In the centre is the symbol of three fox skins, which represents the letters *m s.* The shepherd's staff on the right stands for ruler. The two door bolts at the bottom represent forms of the letter *s.*

Egyptian hieroglyphics, *left,* were painted inside the tomb of the son of the pharaoh Ramses III during the 1100's B.C. The pharaoh is shown with the Egyptian goddess Isis. The illustration on the right interprets the hieroglyphics painted nearest the head of Ramses.

The earliest *hieroglyphs* (symbols) consisted of pictorial characters known as *pictographs* or *ideograms.* These characters were literal representations of ideas. For example, Egyptians who wished to express the idea of a woman drew a picture of a woman.

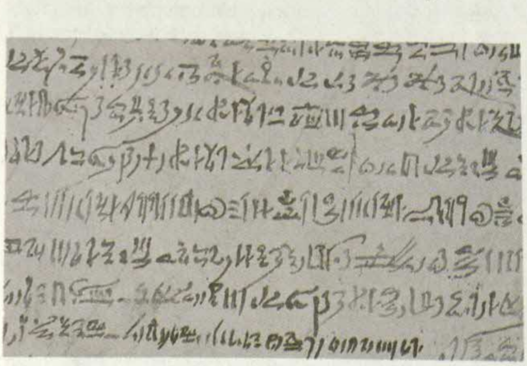
Egyptian hieroglyphs included *determinatives.* Determinatives indicated the class of object to which the preceding hieroglyphs belonged. An example of a determinative might be the symbol for water placed after the name of a specific lake or river. Such determinatives helped explain and emphasize the meaning of other hieroglyphs.

Some hieroglyphic texts are read from right to left and others from left to right, depending on the direction the hieroglyphs face. Scribes also wrote in columns, which were read from top to bottom. Hieroglyphs often served as decoration. Sometimes, the symbols were painted with brilliant colours or covered with gold.

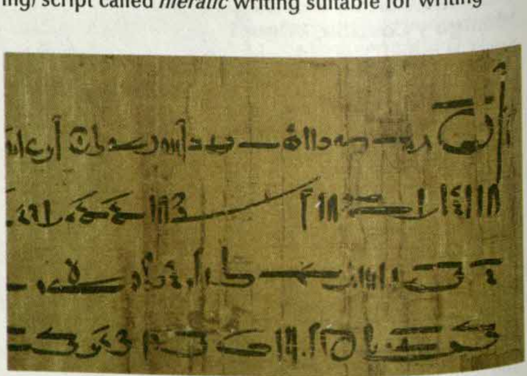
As writing became more common, the need developed for a material that was easier than stone to write on, store, and transport. For this purpose, the Egyptians invented *papyrus,* a paperlike material made from a reed plant. Scribes wrote on papyrus with pens made of sharpened reeds. Soot mixed with water served as ink.

The Egyptians also developed *phonetic hieroglyphs,* also called *phonograms.* Such hieroglyphs, like the characters of modern alphabets, represented the sounds of the language. Some represented only one sound. Others represented combinations of two or three sounds that formed syllables. But the phonetic symbols represented only the sounds of consonants. The Egyptians did not write the vowels. Thus, scholars remain unsure of how the ancient Egyptian language was pronounced.

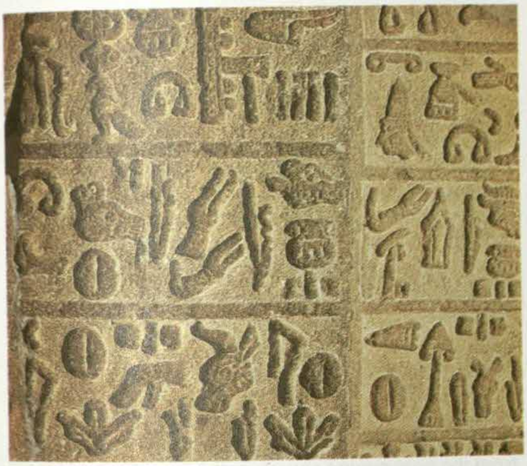
The Egyptians developed a simplified *cursive* (flowing) script called *hieratic* writing suitable for writing



Hieratic writing is a simplified script form of Egyptian hieroglyphics. The text shown above, from the 1100's B.C., is part of a creditor's plea for justice concerning repayment of a loan.



Demotic writing was a form of hieroglyphic script that was used by most Egyptians after about 700 B.C. The example shown above is a portion of a marriage contract written about 365 B.C.



Hittite hieroglyphics represented words or phonetic syllables. The Hittites developed their writing system about 1500 B.C., while they were a leading power in the Middle East.

quickly on papyrus. Hieratic writing resembled hieroglyphic writing in much the same way that modern longhand resembles printing. Scribes used hieratic script for both religious and nonreligious purposes.

Later, about 700 B.C., the Egyptians developed a script called *demotic* that was simpler and could be written faster than hieratic writing. Most Egyptians used this form of writing. Scribes also used demotic script for correspondence and record-keeping.

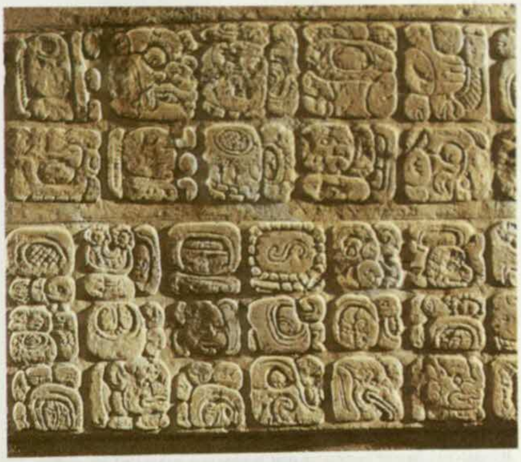
Deciphering hieroglyphic writing. The Egyptians replaced hieroglyphic writing with a phonetic alphabet sometime after the A.D. 300's. Soon the meaning of the hieroglyphs was forgotten. People came to believe that the hieroglyphs really represented a secret and magical sacred code used by Egyptian priests.

In 1799, a French officer in the army of Napoleon I discovered a stone tablet near the mouth of the Nile River near Rosetta, Egypt. The tablet, named the Rosetta stone, carried an inscription in three scripts—Egyptian hieroglyphic, Egyptian demotic, and Greek. By reading the Greek portion of the stone, scholars learned that the text consisted of a decree, issued in 196 B.C., honouring King Ptolemy V.

Scholars tried to translate the Egyptian script using methods similar to modern cryptography. In 1814, Thomas Young, an English doctor and scholar, found that some of the hieroglyphics were phonetic signs. Scholars also learned that hieroglyphs enclosed in an oval ring, called a *cartouche,* represented the names of individuals.

In 1822, a French scholar named Jean François Champollion achieved a breakthrough in deciphering the hieroglyphs of the Rosetta stone. By studying the position and repetition of proper names in the Greek text, he picked out the same names in the Egyptian text. In addition, Champollion's knowledge of Coptic, a modern Egyptian language, enabled him to recognize many ancient Egyptian words in the hieroglyphic part of the text. Eventually, Champollion deciphered the entire text.

Today, grammars and dictionaries enable scholars to read Egyptian hieroglyphic writing easily. Knowledge of ancient Egyptian history would be nearly impossible to obtain without the ability to read hieroglyphics.



Maya hieroglyphics consisted largely of pictorial characters representing ideas or things. The Maya carved hieroglyphics on stone in Mexico and Central America from about A.D. 300 to 900.

Other hieroglyphic writing. In Central America, the earliest examples of Maya hieroglyphs date from about A.D. 300. They consisted chiefly of ideograms, though some scholars believe a number of the signs represent sounds. Most Maya hieroglyphs have not been deciphered. The texts scholars have deciphered deal with religion, astronomy, and the recording of time. Aztec hieroglyphs consisted of pictographs, which also had a phonetic value. The Aztec combined the symbols of several objects to form the sound or name of an object or abstract idea not represented by a pictograph. These symbols resemble modern *rebus* writing (see **Rebus**).

The Hittites developed a hieroglyphic writing system about 1500 B.C. Some Hittite symbols represented words. Others represented phonetic syllables.

Related articles in ***World Book.*** For examples of hieroglyphics, see:

Alphabet
Aztec (picture: Aztec writing)
Cartouche
Hittites
Maya (picture: Maya writing)
Numeration systems (The Egyptian numeral system)
Rosetta stone

Higgins, Andrew Jackson (1886-1952), an American shipbuilder, was one of the largest builders of small craft during World War II. His firm, the Higgins Aircraft Company and Higgins Engine Company, Inc., also made plywood cargo planes for the Army. After the war, the firm made prefabricated houses. He organized his business in 1930.

Higgins was born in Columbus, Nebraska. He began building boats when he was 12 years old. Later, Higgins worked as a timber merchant and organized his own timber company.

Higgins, Henry Bournes (1851-1929), became famous in Australia for his *Harvester industrial award* of 1907. Higgins proposed a national basic wage for labourers to meet "the normal needs of an average employee as a human being in a civilized society." The federal government eventually accepted the award as Australia's first basic wage.

Higgins was born in Ireland. From 1904 to 1906, he was attorney general of Australia. He settled in Australia in 1870. In 1906, he became a judge of the High Court and of the Commonwealth Arbitration Court. But he resigned in 1920 as a protest against alleged political interference.

High blood pressure. See Hypertension.

High Church. See Anglicans (Episcopalians).

High Commission, The Court of, was the most important of the English *ecclesiastical* courts. These courts were set up to hear cases concerned with offences against the Church of England. The Court of High Commission developed during the 1500's. Its powers were fully defined in 1611. It heard cases dealing with heresy and other ecclesiastical offences, and crimes of the clergy. It also heard divorce suits.

The Court of High Commission was the church equivalent of the Court of Star Chamber (see **Star Chamber**). It caused great resentment because many of its activities, as well as its very existence, opposed the principles of common law in England. Sometimes, bishops who sat as judges in the Court were themselves involved in the dispute being heard. The Court of High Commission was abolished by the Long Parliament in 1641.

High-fidelity system is electronic equipment that reproduces sound with a high degree of accuracy. High-fidelity systems are designed to maintain the greatest possible *fidelity,* or faithfulness, to a sound source without producing distortion or background noise. High-fidelity systems are informally called *hi-fi systems.* They are often called *stereophonic sound systems,* or *stereos,* because they deliver *stereophonic sound.* Stereophonic sound involves the distribution of sound signals through two or more separate channels. In this way, stereo systems enable sounds to be reproduced from their proper directions.

There are two basic types of high-fidelity system—*console systems* and *component systems.* Consoles consist of parts that a manufacturer has wired and assembled into a frame or cabinet. Component systems are made up of individual *components* (parts) that are purchased separately and connected by the consumer.

Component systems have several advantages over consoles. For example, consumers can easily combine different models and types of components to suit their individual needs, budget, and taste. A component can also be added, exchanged, or repaired without replacing the entire system. This article deals mainly with component systems.

Parts of a hi-fi system

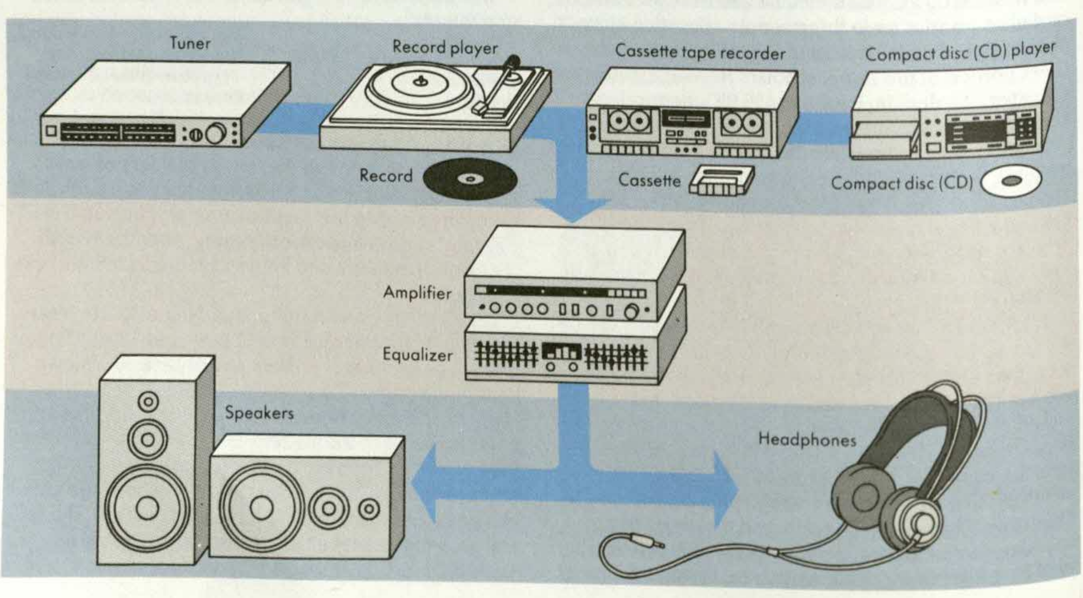
A component hi-fi system consists of three general types of parts—*programme source, amplifier,* and *reproducer.* Sounds travel in the form of electric signals from the programme source to the amplifier and then to the reproducer, where the signals are converted back into sounds. Programme sources include tuners, record players, tape recorders, and compact disc players. Speakers and headphones serve as reproducers.

The tuner receives broadcast radio signals and converts them into weak electric signals. A tuner can be adjusted to receive signals of only a certain frequency—that is, the signals from a selected radio station. Some tuners pick up frequency modulation (FM) waves only, but others can receive amplitude modulation (AM) signals as well (see **Radio** [Kinds of broadcast waves]). In many high-fidelity systems, the tuner is combined with the amplifier into a single unit called a *receiver.*

The record player reproduces sound from a groove on a vinyl gramophone record. The record player of a component hi-fi system is made up of three main parts: (1) the turntable, (2) the cartridge, and (3) the tone arm.

Some parts of a high-fidelity system

High-fidelity systems reproduce sound with a great degree of accuracy. The parts pictured in the top level of the diagram below produce weak electric signals, which are strengthened by the parts shown in the middle section. Loudspeakers and headphones then convert the signals into sound.



The turntable. Many people use the word *turntable* to refer to the entire record player. However, a turntable is technically the flat metal plate on which a record sits. The plate is covered with a rubber or felt pad to prevent it from scratching the record. Most turntables are run by either a *belt drive* or a *direct drive.*

A belt drive consists of a flexible rubber belt stretched from a wheel below the turntable to a *stepped* pulley—that is, a pulley with two separate diameters. The pulley is attached to the shaft of a motor. The speed of the turntable's rotation is changed by raising or lowering a forklike mechanism. In this way, the belt becomes engaged with the different diameters of the pulley. The speed of the motor remains the same, whether the turntable spins at $33\frac{1}{3}$ revolutions per minute (rpm) or 45 rpm.

With a direct drive system, the turntable is mounted directly on the motor shaft. The speed of the motor is controlled by a device called a *quartz crystal oscillator.* One can change the frequency of this oscillator and thus change the speed of the turntable's rotation.

The cartridge picks up vibrations from the *stylus* (needle), which moves from side to side and up and down in the groove of a record. It then uses magnets and coils to convert these vibrations into weak electric signals.

The tone arm, also called the *pickup arm,* holds the stylus, the cartridge, and the wires that carry electric signals to the amplifier. Some record players are equipped with a *linear tracking* tone arm, which moves in a straight line across a record. However, in most record players, the tone arm is mounted on a pivot. The pivot enables the cartridge and stylus to move toward the centre of the turntable without causing too much wear to the record. A weight at the pivot end of the tone arm balances the pressure of the stylus in the record groove. Too much pressure on the stylus causes poor sound quality and increased record wear. If there is too little pressure, the stylus will skip across the record.

The tape recorder records and reproduces sounds on magnetic tape. During recording, electromagnetic *heads* on the tape recorder convert electric signals into varying magnetic patterns on the tape. In reproducing or playing back sounds, the heads change the magnetic patterns into electric signals. There are two types of tape recorders used in component high-fidelity systems—cassette and reel-to-reel.

The compact disc (CD) player reproduces sound that has been recorded on a small, plastic-coated disc in *digital,* or numerical, code. A CD player spins the disc rapidly and uses a *laser* to read the code on the disc. The laser produces a concentrated beam of light that is broken into pulses of light as the laser moves from the centre to the edge of the disc during play. The CD player converts the pulses of light into weak electric signals.

Two sizes of discs are commonly used in CD players. One size measures about 12 centimetres in diameter. The other measures about 8 centimetres across. Some CD players require an adapter to play an 8 centimetre disc.

With a CD player, a listener can skip forward or backward to any point on the disc. Most models can also be programmed for selections to be played in a certain order. CD players are an excellent programme source because they produce no background noise.

The amplifier strengthens the weak electric signals that it receives from the tuner, record player, tape recorder, and compact disc player. An amplifier's power is rated by the number of watts in each stereo channel. Good high-fidelity systems require amplifiers with at least 50 watts per channel. Many amplifiers feature 100 watts or more per channel. In general, amplifiers with greater power provide better sound. However, speakers are designed to accommodate only a certain range of power, so the amplifier in a system must be coordinated with the speakers. Too much power from an amplifier can damage the speakers.

Amplifiers or receivers serve as the control centre of stereo systems. They have a switch to turn the power of the hi-fi system on and off. They may also have switches to adjust loudness, tone, and the balance of stereophonic sound between the two channels. Some amplifiers are equipped with such additional controls as a *filter control* and a *microphone input.* A filter control helps reduce noise from record scratch and tape hiss. A microphone may be plugged into the system by means of a microphone input.

An *equalizer* and a *time delay* may also be added to a hi-fi system to improve stereo balance and general sound quality. An equalizer alters the pitch, or frequency, of sounds. Pitch falls into three groups—*bass, midrange,* and *treble.* The tone control of an ordinary amplifier adjusts only bass and treble, but an equalizer includes an adjustment for midrange as well. An equalizer therefore allows more precise tone control, because it can be used to increase or decrease the loudness of any range of frequencies.

The time delay puts off a sound signal for a certain length of time. In this way, a time delay may help to represent sound more accurately, especially in rooms where sound is not distributed evenly.

Speakers receive electric signals from the amplifier and convert them into sound waves. Stereophonic hi-fi systems require two speakers for reproducing sound—one speaker for the left stereo channel and one for the right.

Headphones, like speakers, change electric signals into sound waves. Most headphones consist of two cushioned earpieces connected by a headband to fit comfortably over the head and ears. Headphones are plugged into the amplifier, and each earpiece carries one stereo channel. Headphones are sometimes called earphones.

History

The term *high fidelity,* in relation to sound, was used at least as early as the 1930's. However, early radios and record players had poor sound quality by today's standards, and the 78 rpm records of the time produced excessive background noise. In 1948, $33\frac{1}{3}$ rpm records, called long-playing (LP) records, began to replace 78 rpm records. LP's reproduced sound with greater fidelity than did previous records.

Several developments of the 1950's and 1960's eventually led to a demand on the part of consumers for equipment that could produce both better quality sound and greater volume. For example, rock 'n' roll music became popular in the mid-1950's, and stereophonic records appeared on the market in 1958. Also, radio stations began broadcasting music and drama in stereo during the 1950's and 1960's.

As manufacturers designed higher-performance equipment, they found that components produced separately provided sound quality superior to that of consoles. By the late 1960's, engineers had developed *quadraphonic sound* systems, which use four channels and four speakers. Digital recording techniques and CD players were developed in the late 1970's and early 1980's. By the 1990's, CD was replacing LP. Also in the 1980's, manufacturers introduced hi-fi components that could be connected to television sets and video cassette recorders (VCR's).

See also **Headphones; Radio; Record player; Speaker; Tape recorder.**

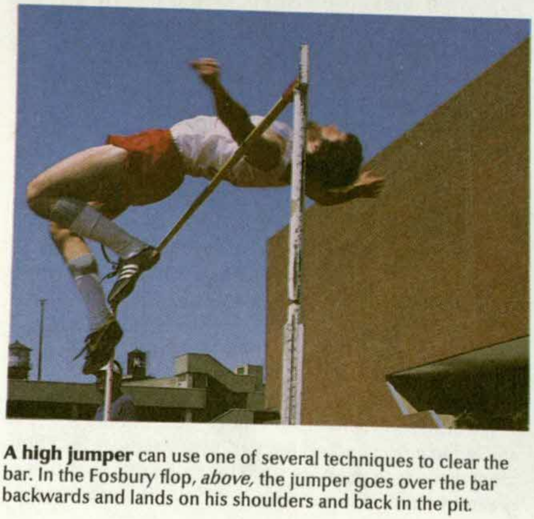
High jump is an athletics event in which an athlete tries to jump over a bar supported by two posts at least 4 metres apart. The jumper lands in a pit of foam rubber, or on an air-inflated pad.

A jumper takes a running start and may approach the bar from any angle. Almost all high-jumpers use the *Fosbury flop,* while a few use the *straddle.*

Jumpers using the Fosbury flop take off on their outside foot—that is, the foot farthest from the bar. They turn their back to the bar, arch their back over the centre of the bar and kick their legs out to clear it. They land on their shoulders and back.

In the straddle, jumpers take off on their inside foot—the foot nearer the bar. They approach at a slow run and, when ready to jump, plant their take-off foot about an arm's length from the bar. As they spring, their outside leg and both arms swing upward. The jumpers have their abdomen and face toward the bar when they kick their outside leg over. They roll over so their inside leg comes over last.

The straddle was by far the most popular high-jump style until the late 1960's, when it was largely replaced by the Fosbury flop. This style was originated by Dick Fosbury, a student at Oregon State University, U.S.A. Using this new jumping style, Fosbury set an Olympic high-jump record of 2.24 metres at the 1968 Summer Games.



A high jumper can use one of several techniques to clear the bar. In the Fosbury flop, *above,* the jumper goes over the bar backwards and lands on his shoulders and back in the pit.

In an athletics meeting, the bar is placed at successively higher levels. Jumpers remain in the competition until they miss three consecutive times. They get credit for the highest height they clear.

For world championship figures in the high jump, see the tables with the articles **Athletics** and **Olympic Games.**

High kings reigned in Ireland between the A.D. 200's and the 1100's. The title *high king* was a nominal one. It did not necessarily give a king authority over other kings.

In the A.D. 200's, Cormac mac Airt reigned from Tara, Meath, and called himself *Ard Rí* (High King). A succession of high kings maintained the superiority of Tara until the 560's. One of the most important successors was Niall of the Nine Hostages (379-405). His descendants retained the high-kingship for several hundred years.

King Brian Boru, who reigned from 1002 to 1014, was the most illustrious and powerful of the high kings (see **Brian Boru**). He defeated Danish invaders at the Battle of Clontarf—a turning point in Irish history. The last high king was Rory O'Connor, also known as Roderic, who died in 1198.

High-lift devices. See **Aerodynamics.**

High Peak (pop. 83,800) is a local government district in Derbyshire, England. It lies in the north of the Peak District and includes much beautiful scenery. Buxton is a market town and tourist centre. Glossop is a centre of the plastics industry. Chapel-en-le-Frith is a small market town near Whaley Bridge. Local limestone is crushed for the manufacture of cement at a works in the Hope Valley. See also **Derbyshire.**

High priest was the head of the Jewish priesthood in later Biblical times until the destruction of the temple in Jerusalem in A.D. 70. He represented the Jewish people before God. His duties were to take care of the Temple and sanctuary and all its services. He was also the chief of the *Sanhedrin,* the highest governing council of the Jews. When he became high priest, he was anointed with holy oil as a symbol of authority.

There were special rules for a high priest's conduct (Lev. 21). For example, he was permitted to marry only a virgin of Israel. His official costume included a blue robe, partly covered with an embroidered garment called an *ephod.* On his head he wore a linen turban called a *mitre.* He had a golden breastplate set with 12 precious stones that bore the names of the Hebrew tribes. Only the high priest was permitted to enter the Holy of Holies (see **Tabernacle**). He then wore a white linen robe.

Aaron, the brother of Moses, is believed to have been the first high priest of Israel (see **Aaron**). At first, a high priest's position was hereditary and he served for life. But by 100 B.C., high priests were selected for office. Later, Herod and the Romans appointed and dismissed high priests as they wished.

High school is a school in the United States and Canada that provides several years of education for young people between the ages of 14 and 17 beyond the junior level. High schools are called *secondary schools* in other countries. High schools provide a general education and prepare students for college or for a vocation.

High seas are the areas of the oceans that lie outside the authority of any nation. They generally begin 200 nautical miles from the coasts of nations that border the oceans. A nautical mile is equal to about 1.9 kilometres. The high seas are also called *international waters.* Areas of the oceans over which nations exercise control include a nation's *territorial waters* (see **Territorial waters**).

All nations are expected to follow international rules regarding the high seas. Under international law, the high seas are open to every nation for fishing, travel, and research. All nations have equal rights on the high seas and must respect one another's rights.

During wartime, international law allows neutral nations to continue trading with other neutral nations and with nations at war. In such times, however, the ships of neutral nations are not supposed to carry *contraband of war* (illegal goods). The nations at war decide what materials they consider contraband of war.

Nations have long argued over the law of the sea. During the 1960's and 1970's, the United Nations (UN) worked to establish a set of sea laws that would satisfy all nations. This work led to the adoption of the Convention on the Law of the Sea in 1982. This treaty was signed by more than 100 UN members. In general, it would give countries exclusive rights to drill for oil and gas up to 350 nautical miles (648 kilometres) from shore and to fish within 200 nautical miles (370 kilometres) of their coasts. Within this 200 nautical miles, called the *exclusive economic zone,* all nations would have high seas rights of navigation and flight. But the coastal nations would control all the economic resources found within this zone.

Most nations agree that mining is not a part of the freedom of the sea and can proceed only under the terms of the treaty. The treaty will not become official until ratified by 60 nations, but most terms of the treaty are already being followed.

See also **Contraband; International law; Neutrality; Pirate; Right of search.**

High Wycombe. See **Wycombe.**

Higher education. See **University; Education.**

Highland games are athletic, piping, and dancing competitions held in Scotland every summer. They are also known as *Highland gatherings.* Competitors come from all parts of Scotland, dressed in their tartans (see **Tartan**). The games have changed little since early times. They include running, jumping, throwing the hammer, tossing the caber, and putting the weight. Pipers compete in playing marches, dances such as jigs, reels, and strathspeys, and special pipe music called *piobaireachd.* Highland dancers vie with each other to the music of the pipes. At some games, there are pipe band competitions, which are probably the most colourful of all the events.

Highland games are held in many parts of Scotland every year. Two of the principal games are the Royal Highland Gathering, or Braemar Gathering, held at Braemar, Grampian Region, in August or September, and the Northern Meeting Highland Gathering, held at Inverness in September.

The Highland games developed from informal gatherings on the local *machair* (pasture land) at which people in Scotland used to compete in feats of strength and skill. The events included everyday activities, such as walking, running, jumping, handling trees and weights, dancing, and singing.

Highland Region covers a vast area of northern Scotland. An area of extremes, the region includes the highest mountain in the United Kingdom (UK), Ben Nevis, and the deepest loch, Loch Morar. It also includes the most northerly point on the UK's mainland, Dunnet Head, and the most westerly point, Ardnamurchan Point.

Highland Region was set up in 1975, when Scotland's local government was reorganized. It occupies nearly a third of the total area of Scotland. The region covers most, but not all, of the part of Scotland called the *Highlands.* Before Highland Region was set up, the area it covers was five separate counties. They were Caithness, Inverness-shire, Nairnshire, Ross and Cromarty, and Sutherland. In the reorganization, parts of Inverness-shire and Ross and Cromarty became a separate local government unit, Western Isles. Highland Region took over parts of the former counties of Argyllshire and Moray.

People and government

Hard living conditions and poor employment opportunities caused many people to leave the region until the 1960's. Since then, the economy has improved, and the population has started increasing. In some areas in the west of the region, 50 per cent of the people speak the Gaelic language. But Gaelic has declined in most parts. See **Gaelic language.**

Customs and recreation. Two ancient Gaelic traditions that still continue in Highland Region are the *ceilidh* and the *mod.* The ceilidh is a winter evening's entertainment, with spontaneous singing, music, discussions, and storytelling. The mod, similar to an *eisteddfod* in Wales, includes competitions in Gaelic poetry, prose, and music. Traditional Highland costume, including tartan, plaid, and kilt, is often worn.

Many national games, such as soccer, are played in Highland Region. Traditional Highland recreations include shinty and Highland games (see **Shinty**). Fishing, especially for salmon and trout, and golf are extremely popular throughout the region.

Places to visit

Following are brief descriptions of some of the outstanding places to visit:

Aviemore is the United Kingdom's main skiing centre. Chair lifts take skiers and tourists up the mountainsides.

Carrbridge has Landmark, an exhibition hall that has spectacular displays of Highland history.

Dornoch is a historic town with a beautiful cathedral, sandy beaches, and a golf course.

Fort William is a centre for visiting Ben Nevis and the nearby sea lochs of Eil, Leven, Linnhe, and Sunart.

Inverness is a centre for visiting Culloden battlefield, the beautiful scenery of Glen Affric, Loch Ness, and impressive hydroelectric power dams at Kilmarack and Aigas.

Kingussie has a wildlife park and the Highland Folk Museum.

Skye is a beautiful island with much to see, such as Dunvegan Castle, folk museums, and a malt whisky distillery.

Fort William is a tourist centre for Highland Region. The town lies close to Ben Nevis, which is the highest mountain in Britain.

Local government. The region is divided into eight administrative districts: *Badenoch and Strathspey,* which includes Grantown and Kingussie; *Caithness,* which includes Thurso and Wick; *Inverness; Lochaber,* which includes Fort William; *Nairn; Ross and Cromarty,* which includes Dingwall; *Skye and Lochalsh;* and *Sutherland,* which includes Dornoch. A single police force covers Highland Region and also Orkney, Shetland, and Western Isles. Law courts are centred on Inverness.

Economy

Agriculture and forestry. Highland Region contains some of Britain's poorest land. Farming is dominated by hill sheep farming. But on the lowlands of Caithness, and along the Moray Firth, farmers produce grains, particularly barley, and some dairy produce. The fertile soil of the Black Isle, between Inverness and Cromarty, produces potatoes. Along the western edge of the region, much farming is done by *crofters* (see **Crofter**). Forests make up more than 10 per cent of the land. The Highland deer population is about 150,000. About 25,000 are killed each year to produce venison.

Fishing. The main fishing ports are Mallaig, Kinlochbervie, Ullapool, and Wick. Together they produce about a quarter of Scotland's annual fish catch. Fish farming is growing, particularly for salmon and shellfish.

Manufacturing. Smelting factories produce aluminium at Fort William and Kinlochleven. A mill at Fort William produces paper. Dounreay has atomic energy reactors. Industries producing equipment for the North Sea oil industry are important in the areas around Cromarty Firth and Moray Firth. Other industries in the region include generating hydroelectric power, distilling whisky, and making textiles and knitwear.

Tourism is a major part of the region's economy. The main tourist centres are Fort William and Inverness. Aviemore is a centre for winter sports, and skiing is steadily growing in popularity.

Transport and communications. Because of the region's mountains, transport is restricted. There are few railways and roads. But roads improved steadily during the 1970's and 1980's. Air transport plays a small but important part in the region's internal transport.

Communication services, such as television and telephone, are not available in some of the more remote areas. But the region has about 12 local weekly newspapers. A BBC local radio station, Radio Highland broadcasts from Inverness in English and Gaelic. *Radio nan Eilean,* the BBC's Gaelic station on Stornoway, in Western Isles, also serves Highland Region. An independent station, Radio Moray Firth, serves Inverness and the Moray Firth area.

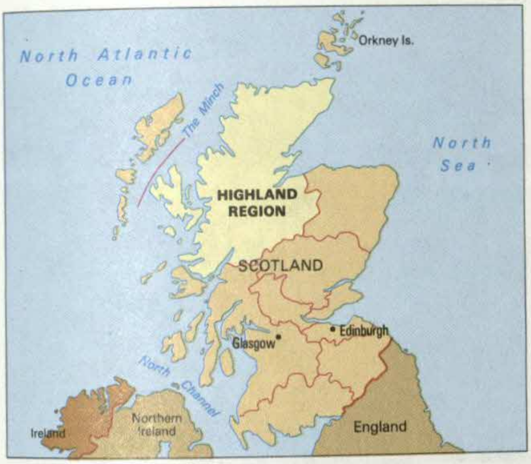
Land

Location and size. Highland Region makes up the northern part of the Scottish mainland and extends into the Inner Hebrides, a group of islands off the northwest coast. It is bounded on the west and north by the Atlantic Ocean and on the east by the North Sea. It borders on Grampian Region to the southeast and on Tayside and Strathclyde regions to the south. Its maximum distance from north to south is about 215 kilometres and from east to west, including the Isle of Skye, 185 kilometres.

Land features. Much of the impressive scenery of Highland Region was carved out by glaciers. The region's many *lochs* (lakes) lie in valleys eroded by the glaciers. Huge indentations on the coastline lie where the sea has flooded other glacial valleys. The northern part of the region, and the land along the Moray Firth in the

Facts in brief about Highland Region

Administrative centre: Inverness.
Largest towns: Inverness, Thurso, Wick.
Area: 25,120 km².
Population: *1991 census*—209,419.
Chief products: *Agriculture*—dairy products, fish, mutton, timber, venison, wool. *Manufacturing*—electricity, oil industry equipment, paper, textiles, whisky.



Highland Region is the most northerly region on the Scottish mainland. It includes the island of Skye.

east, is lowland. The rest of the region is highland, divided by Glen Mòr, a huge valley running northeast. Ben Nevis, the highest mountain in the United Kingdom, lies near Glen Mòr. The mountain reaches a height of 1,343 metres (see **Ben Nevis**). The Cuillin Hills on the Isle of Skye are the steepest hills in the United Kingdom.

Rivers and lakes. Most of the region's rivers are small. The larger ones include the Glass and the Spey, which flow into the North Sea. Highland Region has many lochs, including Loch Ness.

Climate. Average annual rainfall varies greatly. It is about 500 millimetres in the east and nearly 5,000 millimetres in the west. On the mountains, much of the precipitation falls as snow. Average temperatures at sea level in January range from 3° to 5° C. July temperatures range from 12° to 15° C. Weather conditions in the higher mountain areas are bleak.

History

In the A.D. 400's, a tribe of people called Scots travelled from Ireland to colonize the southwest corner of the Highlands. The Scots' Gaelic language and culture gradually spread across the region.

From the 700's to the 1100's, the Vikings attacked various parts of the region many times. Caithness and much of the land along the western coast became part of the Viking kingdom of the Isles.

By the 1400's, the *clan* structure of communities was well developed (see **Clan**). For 400 years, the clan system dominated the Highlands. But it was almost destroyed after Bonnie Prince Charlie and his Highland forces were defeated at the Battle of Culloden in 1746. After this defeat, Highlanders were not allowed to bear arms, to use their tartans, or to wear traditional dress. The clan chiefs became landowners.

In the 1700's, roads were built across the area, making communications easier. Landowners cleared many people from their land to make way for sheep farms. Many people emigrated. Some drifted to the developing industrial areas in central Scotland. Others settled in *crofts* (small farms) on the coast.

During the 1800's, many Highland crofters depended for food on potatoes, which were on occasions destroyed by blight. Public sympathy for the plight of the crofters led the government to appoint the Crofters' Commission. The commission reported that the area suffered from the small size of holdings, high rents, and poor transport facilities. The Crofters Act of 1886 corrected many of these problems, and ensured that crofting survived.

Related articles in *World Book* include:

Caithness
Caledonian Canal
Culloden
Hebrides
Jacobite risings
Nairn
Ross and Cromarty
Skye and Lochalsh

Highlands. See **Highland Region.** See also **Central Region; Grampian Region; Strathclyde Region; Tayside Region.**

Highway. See **Road.**

Highwayman was a person who robbed travellers during the 1600's and the early 1700's. A highwayman usually pointed a pistol at travellers, forcing them to stop. The highwaymen then robbed the travellers and rode away.

Highwaymen have often been the subject of romantic fables. For example, such outlaws as Robin Hood, Pancho Villa, and Zorro were highwaymen. They won the reputation of taking from the rich and giving to the poor. But their charity was often a means of setting up a network of spies to warn them of danger.

An important factor enabling highwaymen to succeed was their use of the *flintlock* pistol. This type of pistol was easier to fire and more reliable than earlier types. Flintlock pistols became available in England in the early 1600's. During the 1640's, the army of King Charles I was defeated in the Civil War. As a result, many young horsemen were outlawed and became highwaymen. By the mid-1700's, new police organizations had developed, and highwaymen were no longer successful.

Some highwaymen operated before the Civil War. An example is John Clavell, who in 1626 was pardoned from hanging for his crimes. Clavell spent his time in prison writing a book on highway law.

Claude Duval was a famous highwayman of the late 1600's. He was a Frenchman who travelled to England with King Charles II. Duval soon took to the road, and he acquired a romantic reputation. He was hanged at Tyburn Tree and buried in St. Paul's Church, Covent Garden, London, under a marble slab bearing the words: "Duval the ladies' joy, Duval the ladies' grief."

The most famous highwayman is Dick Turpin. Turpin was a minor robber, and his reputation results from legends. The most famous Turpin legend is told in Harrison Ainsworth's novel *Rookwood* (1834) and describes a ride from London to York. This ride, of 305 kilometres in 16 hours, was probably made by another highwayman, William Nevison, in 1676.

Hijacking is the seizure of a commercial vehicle by force or the threat of force. For years, trucks have been hijacked and their cargo stolen. Today, hijacking involves chiefly aeroplanes and is also called *skyjacking* or *air piracy.* Since the late 1960's, skyjackers have seized several hundred planes. In most of these incidents, no one was killed. But several skyjackings resulted in the loss of lives and the destruction of aircraft. A number of governments impose severe penalties for skyjacking.

Most plane hijackers threaten to destroy an aircraft or kill the people aboard if their demands are not met. Some hijackers make political demands, such as certain policy changes by a nation's government or the release of imprisoned associates. Others demand a large sum of money in exchange for the safe return of the plane and the people aboard. Still other hijackers want to flee a country in order to escape punishment for a crime.

The name *hijacking* originated in the United States in the 1920's. Alcoholic beverages were prohibited and gangsters used to hijack truckloads of illegal liquor from each other. One of the first skyjackings took place in 1930 in Peru.

During the 1960's and early 1970's aeroplanes were hijacked most often by political terrorists, particularly Palestinians and Cubans. By 1973 it became common practice for airline passengers and their baggage to be searched or X-rayed for weapons before boarding planes. Armed guards were also on duty at airports. Since then the number of skyjackings has fallen sharply, particularly in the United States.

The domestic law of most nations considers the hijacking of a transnational airliner to be a crime. The Hague Convention of 1970 is a treaty providing international law for the trial and punishment of skyjackers. About 130 nations have agreed to support the terms of the treaty.

See also **Airport** (Airport security; picture: Security checks at airports); **Aviation** (A new age of flight).

Hijra, another spelling for *Hegira.* See **Hegira.**

Hiking is a healthy, relaxing form of exercise. Millions of people of almost every age enjoy hiking all year round. A hike can last for a few hours or for several weeks. Many experienced hikers find special pleasure in wilderness areas in national parks and forests. But many people prefer to hike in local parks or even on city pavements.

For most hiking, people need only clothing suitable for the weather, including comfortable shoes or boots. Beginning hikers should start with walks that last no longer than a day. As their endurance increases, they may take overnight hikes. Eventually, they may go on camping trips that last several days or weeks.

A hiker can help provide for his or her safety by always having at least one companion. Hikers should be prepared for sudden changes in the weather. They also should know basic first-aid skills so they can treat such conditions as blisters and frostbite. Skill in using a map and a compass can be important so that they can find their way in unfamiliar areas.

In one of the most popular types of hiking, called *backpacking,* people carry food, clothing, a tent, and other equipment on their backs. Backpackers can spend many days in remote areas where supplies cannot be obtained.

A hiking sport called *orienteering* involves map reading and using a compass. Hikers compete over an established cross-country course. With a map and a compass, they must locate checkpoints scattered throughout the course. The person who finds all the checkpoints first is the winner.

During the winter, many hikers enjoy two cross-country sports, *cross-country skiing* and *snowshoeing.* Crosscountry skiing, for which a person should receive professional instruction, is hiking on skis over snow. In snowshoeing, which requires no special training, hikers wear snowshoes. See **Skiing** (Nordic skiing).

Hikers on a camping trip carry backpacks containing food, cooking equipment, bedding, clothing, and other items.

Mountain climbing, also called *mountaineering,* is a special type of hiking that can be both difficult and dangerous. Hikers should take a course in mountaineering before attempting a climb, and they should always be accompanied by an experienced climber.

Many organizations provide information for hikers. They include the Scouts, Girl Guides, and local hiking clubs.

See also **Camping.**

Hill is an elevation of the earth's surface that has a distinct summit. It has much less surface area than a mountain and is lower in elevation. Hills rise less than 305 metres above the surrounding area, whereas mountains always exceed that height. However, a hill is not simply a small mountain. It is formed in a considerably different way.

Hills may be classified according to the way they were formed and the kinds of materials they are made of. There are two types, constructional and destructional. *Constructional hills* are created by a build-up of rock debris or sand deposited by glaciers and wind. Oval-shaped landforms called *drumlins* and sand dunes are examples of this type. *Destructional hills* are shaped by the deep erosion of areas that were raised by disturbances in the earth's crust. Such hills may consist of limestone overlying layers of more easily eroded rock.

See also **Butte.**

Hill, Alfred (1870-1960), one of Australia's best-known composers, developed themes from Maori chants and used them in many of his compositions. These works include his song *Waiata Poi,* his cantata *Hinemoa,* his opera *Tapu,* and his string quartet *Maori.* Hill was born in Melbourne, but spent his boyhood in New Zealand. At 15, he went to Leipzig, Germany, to study violin and composition. He returned to New Zealand in 1891. He settled in Sydney in 1895 and became the first professor of composition at the New South Wales State Conservatorium in 1915. He visited the United States and conducted his works there in 1927.

Hill, Archibald V. (1886-1977), an English physiologist, shared the 1922 Nobel Prize for medicine with the German physiologist Otto Meyerhoff. Hill used brilliant techniques to study the production of heat and to measure oxygen consumption during muscular action. His experiments involved measuring extremely small temperature changes lasting only minute fractions of a second.

A. V. Hill

Archibald Vivian Hill was born in Bristol. He studied at Cambridge University. He was professor of physiology at Manchester and Cambridge universities, and research professor at the Royal Society, London.

Hill, David Octavius (1802-1870), a Scottish painter of landscapes and portraits, was the first to apply photography to portraiture. He painted a series of 60 landscapes, entitled "The Land of Burns" (1841), and a historical painting, "Signing the Deed of Demission" (1843-1865). Hill was born in Perth, Tayside Region. For many years, he was secretary to the Royal Scottish Academy.

Hill, Ernestine (1899-1972), an Australian author, wrote the historical novel *My Love Must Wait* (1941). Her novel is based on the life of the explorer Matthew Flinders. The subject matter of Flinders' successful exploration and his unhappy later years lends itself to the romantic and emotional treatment of the novel. Critics praise the novel for its factual accuracy and its skilful reconstruction of historical background. Hill was born in Brisbane and named Ernestine Hemmings. She also wrote several Australian travel books.

Hill, Graham (1929-1975), became a leading motor racing driver. An Englishman, Hill won racing's world title in 1962 by earning the most points in the nine Grand Prix races that made up the championship that year. He was runner-up for the world title from 1963 to 1966, and won the title again in 1968. Hill won the Indianapolis 500 in 1966, the first time he entered the event.

Hill was born in London. He began racing in 1957, for Lotus car builders. In 1960, he started driving for British Racing Motors. Known for his humour, Hill liked to claim he learned much about driving from his troubles with an old car. He said the brakes failed so often he became skilled at stopping the car by scraping the tyres against the kerb. In 1975, Hill was killed in an aeroplane crash.

Hill, Joe (1879-1915), was a Swedish-born songwriter who popularized the goals of the American labour movement through his music. Hill's real name was Joel Hägglund. He was born in Gävle, Sweden. In 1902, he moved to the United States, where he roamed from place to place working at various jobs.

About 1910, Hill joined the Industrial Workers of the World (IWW), a labour organization that wanted to replace the American economic system with a society run by workers. Hill spread the IWW's beliefs by writing new lyrics for popular tunes. His best-known songs included "Casey Jones—The Union Scab" and "The Preacher and the Slave."

In 1914, a jury in Salt Lake City, Utah, convicted Hill of murdering two men and sentenced him to death. During his appeal, concerned people throughout the world protested against the sentence. U.S. President Woodrow Wilson and the Swedish government also tried to save his life, but Hill was executed by firing squad on Nov. 19, 1915. His casual lifestyle, his musical tributes to workers, and finally his dramatic death made him an American folk hero.

Hill, Octavia (1838-1912), a British housing reformer, was equally interested in painting and social work when young. At the age of 14, she managed a workshop for poor girls, but it was through her painting that she became a pupil of the famous art critic, John Ruskin. Ruskin bought some slum property in 1864, and put her in charge. She improved the property, and gave the tenants cultural advantages. In time, she managed property for over 3,000 people.

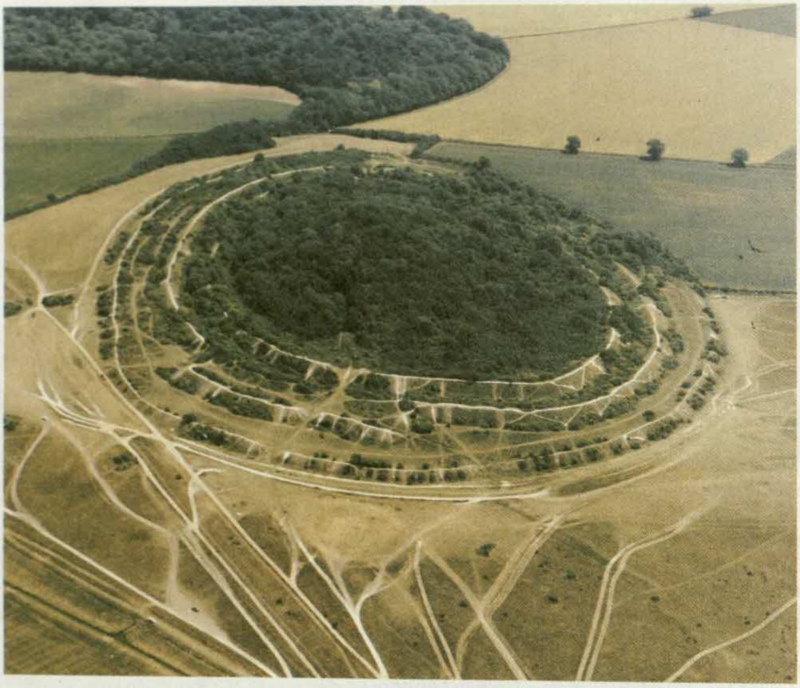
Hill believed that housing conditions could be improved only if those living in them were helped to appreciate finer things. She served on the Central Council of the Charity Organization Society and the Royal Commission on the Poor Laws. But she distrusted organized charity, and emphasized personal relationships, businesslike practices, and self-help. A believer in beauty and recreation, she did much to establish and preserve London's "green belt" of parks and playgrounds. Hill was born in London.

Hill, Sir Rowland (1795-1879), is best known as the originator of the Penny Post. In the early 1800's, the British postal system worked on a complicated scale of charges according to the weight of the letter and the distance it had to go. The person who received the letter paid the postage. In his pamphlet *Post Office Reform* (1837), Hill suggested that there should be a flat rate for sending letters, starting at one penny for any distance inside Britain. He suggested that the charge should be collected in the form of payment for a stamp. The Penny Post was introduced in 1840. As a result, many more people could afford to send letters, and the British Post Office made large profits out of the enormous increase in letter traffic. Hill received a grant of £13,000, and later a pension of £2,000 a year.

Sir Rowland Hill

Hill was born in Kidderminster, England. He taught mathematics at his father's school in Birmingham, and became head of the school. He held official positions in the Post Office from 1846 until 1864.

Hill End is a historic gold town 84 kilometres from Bathurst, New South Wales, Australia. It stands near the Turon River. In August 1851, a gold rush took place in the Tambaroora district. The world's largest unit of gold-bearing material was dug up by Beyer and Holtermann, at Hill End, in 1872. This lump of gold and other metals weighed 235.142 kilograms. It contained 93.310 kilograms of gold.



The ancient hill fort of Badbury Rings in Dorset, England, had circular walls made of earth reinforced by wooden fences. It was protected by deep ditches.

Hill forts are earthworks that are found in many parts of Britain and Ireland. They were built by the prehistoric inhabitants of the islands. Most of those still remaining date from about 200 B.C. The forts were placed at strategic points, generally on hilltops. They were built as circular walls of earth reinforced by fences made of tree-trunks or stones and protected by deep ditches. They varied in size. Some had ditches and *stockades* (fences) to protect cattle, and pits and raised granaries for storing grain. Place names that include *caer, dun,* or *burgh,* or variants of these words, indicate the site of a former fort. Examples are Caer Caradoc, Carlisle, Donegal, London, and Edinburgh (originally called *Dun Edin*).

Hill forts were constructed and used up to the time of the Roman invasion. Most of them were abandoned after the Roman occupation. Hill forts still existing include Badbury Rings, in Dorset, one of the largest.

Hill of Luton, Lord (1904-1989), Charles Hill, won renown as a doctor, radio broadcaster, politician, and administrator. He was chairman of governors of the BBC from 1967 to 1972. He had been chairman of the Independent Television Authority from 1963 to 1967. He was educated at Trinity College, Cambridge, and the London Hospital. He became known as "the Radio Doctor" for his broadcasts before he entered Parliament in 1950. He held several high posts in Conservative governments, including that of minister of housing and local government.

Hillary, Sir Edmund Percival (1919-   ), a New Zealand mountain climber, became one of the first two men to reach the top of Mount Everest and return. On May 29, 1953, he and Tenzing Norgay, a Sherpa tribesman from Nepal, reached the 8,848-metre summit (see **Mount Everest**). Queen Elizabeth II of England knighted Hillary for the achievement.

Hillary made his first five expeditions on Himalayan peaks after World War II. He climbed part of the way up Everest in 1951 and 1952. He wrote *High Adventure* (1955), an account of the 1953 climb. In 1957 and 1958, he blazed a trail from McMurdo Sound to the South Pole for Sir Vivian Fuchs's transantarctic expedition (see **Antarctica** [International cooperation]).

In 1960, Hillary headed an expedition, which was sponsored by *The World Book Encyclopedia,* to climb 8,481-metre Mount Makalu I. The expedition tested the ability of human beings to live without oxygen at high altitudes. The climbers also searched for but did not find evidence of the *Abominable Snowman.* With Desmond Doig, Hillary wrote *High in the Thin Cold Air* (1962) about this climb (see **Abominable Snowman**). Hillary was born in Auckland, New Zealand. His first job was beekeeping.

Sir Edmund P. Hillary

Hillel I (70 B.C.?-A.D. 10?) was the most prominent spiritual leader among the Jews of Palestine from 30 B.C. until his death. He was called Hillel the Elder and was known for his humility and his love for others. Hillel described the meaning of Judaism in simple terms. He explained it in the following way: "What is hateful to thee, do not unto thy fellowman; this is the whole Law; the rest is mere commentary."

A descendant of the house of David, Hillel was born in Babylonia. He settled in Palestine and studied with two great scholars, Shemaiah and Abtalion. He became an authority on interpreting Biblical law.

Because of his great learning, Hillel was made a prince of the Sanhedrin, the highest court in the Jewish state. In 30 B.C., he became president of this court, and held office with distinction for 40 years. Hillel reorganized the extensive body of Jewish law. He made it easier to study by arranging the laws under six headings, where there had previously been 600. These six headings form the six major divisions of the *Talmud,* the book of Jewish laws. Hillel is also described as the first sage to have devised logical rules for interpreting the scriptures.

Hillel founded a school. Thousands of students came to Jerusalem to study under him. Hillel's chief rival was Shammai, who founded a more conservative school of interpretation. Some discussions on their differences in interpretation appear in the Talmud.

See also **Talmud.**

Hillery, Patrick (1923-   ), was president of the Republic of Ireland from 1976 to 1990.

Hillery led the delegation that negotiated the entry of the Republic of Ireland into the European Community. In 1973, Hillery was appointed to the European Community Commission. He became the commission's vice president and had special responsibility for social affairs. See **European Community.**

Hillery was born in County Clare. He was educated at University College, Dublin, and became a doctor of medicine. In 1951, he was elected to Dáil Éireann. Hillery became minister for education in a Fianna Fáil government in 1959. He became minister for industry and commerce in 1965. He was minister for labour from 1966 until 1969, and minister for foreign affairs from 1969 until 1973.

Hilliard, Nicholas (1547-1619), was the first of the great English miniature portrait painters. He was goldsmith, carver, and portrait painter to Queen Elizabeth I, and held a similar appointment under James I. For James, he embossed gold medals. Hilliard was born in Exeter, where he trained as a goldsmith. He began painting miniatures at the age of 13. He also wrote an informative essay on the art of miniature painting.

Hillingdon (pop. 225,800) is an English borough within the Greater London area. It is situated in west London and includes the former boroughs of Hayes and Harlington, Ruislip-Northwood, Uxbridge, Yiewsley, and West Drayton. London's Heathrow airport is located within Hillingdon. The M4 motorway passes through the borough. Hillingdon also includes the town of Uxbridge, which lies on the River Colne and the Grand Junction Canal. St. Margaret's Church in Uxbridge was built during the 1300's and the 1400's.

Hilton, Conrad (1887-1979), an American businessman, was sometimes called the *biggest hotel man in the world.* He organized the Hilton Hotel Systems in 1946. In 1948, he started to build hotels in Istanbul, Madrid, Tokyo, and Berlin. By the mid-1960's, the system included more than 40 hotels in the United States and 40 hotels in 37 other countries. In 1967, the international operations of the Hilton Hotel Corporation became a subsidiary of Trans World Airlines. It is now owned by Ladbrokes.

Conrad Nicholson Hilton was born in San Antonio, New Mexico, U.S.A. After World War I (1914-1918), he started his first hotel chain in Texas and New Mexico.

Hilton, James (1900-1954), an English novelist, sprang to fame with *Goodbye, Mr. Chips* (1934). This sentimental short novel tells of a teacher in an English boys' school. *Mr. Chips* brought attention to an earlier Hilton novel, *Lost Horizon* (1933). This work is the story of a group of people who become stranded in a land where no one grows old. Hilton never quite repeated these early successes, though, like his earlier two novels, *Random Harvest* (1941) became a popular film.

Hilton was born in Leigh, Lancashire. Hilton also shared the Academy Award for best screenplay for his work on the film *Mrs. Miniver* (1942).

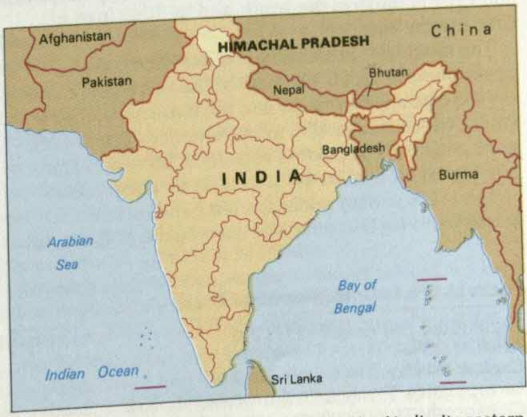
Himachal Pradesh is a wholly mountainous state in the Himalaya in the far north of India. Its name means *Province in the lap of snow.* The territory was formed in 1948 by bringing together 31 small princely states. Himachal Pradesh is a popular trekking region and has a flourishing orchard industry.

People and government. The population comprises a mixture of hill tribes which includes the Gaddis, Gujars, and Lahaulis. More than 95 per cent of the population is Hindu. Pahari, a Hindi dialect, is the local language. Hindi is widely spoken and is used for instruction in schools. The state is the least urbanized in India, with less than 9 per cent of the population living in towns. Only the state capital, Shimla (also spelled Simla), has more than 50,000 inhabitants.

The governor appointed by the president is head of state. The chief minister and his council of ministers are elected from the state's legislature which has 68 members. Himachal Pradesh has four elected members in the *Lok Sabha* (lower house) and three nominated representatives in the *Rajya Sabha* (upper house) in the Indian national parliament. The state has twelve districts.

Economy. The economy depends almost entirely on agriculture. Farmers grow crops on terraces wherever possible, and at higher altitudes they also raise livestock. Only 20 per cent of the sown area is irrigated.

Barley, maize, potatoes, rice, and wheat are the main food crops. Apples are an important cash crop. Other fruit includes peaches, plums, and pomegranates. Ginger and mushrooms are also grown. Sheep and goat



Himachal Pradesh is a state in the far north of India. Its eastern side borders Tibet, a part of China.

Shimla, the capital of Himachal Pradesh, attracts many summer visitors because of its mild climate.

rearing is common. The high quality goatswool produced in the region is known as *pashmina* or cashmere wool (see **Cashmere**).

Forests cover one-third of the state. Timber, fuel wood, gum, and resin are important sources of state revenue. Mines in the state produce small amounts of baryte, dolomite, gypsum, limestone, pyrite, salt, and slate. Himachal Pradesh has little industry. There are resin and turpentine factories, and an iron foundry. Fertilizer production is of growing importance. There are cement plants and an electronics complex near Shimla. Village industries include bamboo crafts, leather tanning, pottery, woodcarving, and wool spinning.

Shimla has an airport at Jabbarhatti. There are also airports at Bhuntar and Gagal. Narrow gauge railway lines link Himachel Pradesh with Haryana and Punjab. There is a broad gauge railway from Nangal in Punjab to Una. The main means of transport are by motor vehicle and on foot. After the 1962 border war between China and India, the Indian government built roads up to the border. The total road length is 17,000 kilometres. Shimla, Kulu, and Manali are popular tourist destinations.

Land. Himachal Pradesh is bordered by Jammu and Kashmir in the north, by Punjab in the west, by Haryana and Uttar Pradesh in the south, and by Tibet (part of China) in the east.

The mountainous landscape of the state contains peaks of more than 6,700 metres. The two main ranges are the Dhaula Dhar range and the more northerly Pir Panjal, which run parallel to one another. Further north are the sparsely populated regions of Lahul and Spiti. The higher mountains are permanently under snow.

The average daily minimum temperature is 2° C in January and 16° C in June. The maximum is 9° C in January and 24° C in June. Shimla receives 150 centimetres of rain a year, of which nearly 80 per cent falls between June and September. The monsoon arrives in the middle of June and lasts until the middle of September (see **Monsoon**). Snow is common in winter.

Facts in brief about Himachal Pradesh

Population: *1991 census*—5,111,079.
Area: 55,673 km².
Capital: Shimla.
Largest cities: Shimla, Kulu, Manali, Dalhousie, Dharamsala.
Chief products: *Agriculture*—apples, rice, wheat, wool.
Manufacturing—Beer, electronic goods, resin, turpentine.

The major rivers are the Chenab, the Ravi, and the Beas in the west and the Sutlej and the Jumna (Yamuna) in the east. The Bhakra Dam across the Sutlej created the largest lake in the state in 1971.

History. The early inhabitants of Himachal Pradesh were nomadic tribes, including the Dahsas, Kinners, Kirates, and Kharasas. The Maurya, Kushana, and Gupta rulers, in turn, forced the region to accept their rule. After the decline of the Gupta Empire, 31 independent kingdoms reemerged. The state of Chamba was the most important. They eventually became tributaries of the Mughal empire under Akbar. During the 1600's and 1700's, Basohli, Kangra, and Guler developed as major centres of painting. Afghans, Sikhs, and Gurkhas invaded Himachal Pradesh after the fall of the Mughal Empire. Maharajah Rangit Singh brought the area under his control in the 1800's. The British took over the princely states following the Anglo-Nepal War of 1815.

The British founded Shimla in 1819 as their summer headquarters. After India became independent in 1947, Shimla served as the temporary capital of East Punjab. Since 1966, it has been the state capital of Himachal Pradesh. Dharamsala has been the home of the Dalai Lama since the Chinese takeover of Tibet in 1956.

See also **Dalai Lama; India.**

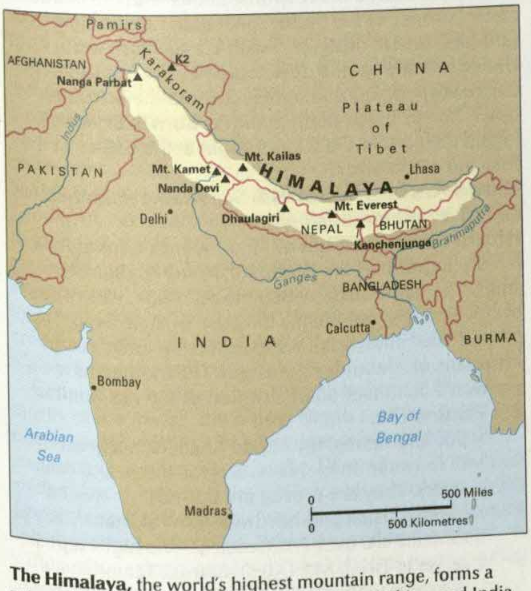
Himalaya, also called Himalayas, is the highest mountain system in the world. The name *Himalaya* comes from the Sanskrit language and means the *House of Snow,* or the *Snowy Range.* The Himalaya consists of several parallel mountain ranges.

The mountains extend in a 2,410-kilometre curve across southern Asia from the Pamirs, west of the great bend of the Indus River, eastward to the great bend of the Brahmaputra River. They form a barrier that separates northern India from the plateau of Tibet, in China. Parts of the Himalayan system are as much as 320 kilometres wide. The Himalaya joins with other mountain ranges of Asia that stretch east and west. The Karakoram

The Himalaya is a region of rugged, impassable mountains and steep valleys like this one in Himachal Pradesh, in India.

mountain system, which includes the Karakoram, or Mustagh, Range and three lesser ranges, is the northwestern extension of the Himalaya.

Peaks. The Himalaya rises in steps from the plains of northern India, which have an elevation of about 300 metres above sea level. Mount Everest, whose official height is 8,848 metres, lies between Tibet and Nepal. It is the highest mountain in the world. K2 (8,611 metres), in the Karakoram Range in northern Kashmir, is the world's second highest mountain. K2 is also called Mount Godwin Austen, or Dapsang.



The Himalaya, the world's highest mountain range, forms a natural barrier between the Tibetan plateau of China, and India and Nepal.

One of the most famous peaks in the Himalaya is Mount Kailas (6,714 metres), which lies in Tibet. The Tibetans call it Kang Rimpoche (the *Mountain of Precious Snow*). This mountain is holy to the Hindus and Buddhists and is said to contain the thrones of their gods. Pilgrims from all parts of central Asia and India climb the mountain. They usually climb on foot, and the journey takes them from tropical jungles to freezing heights. Lying below the peak is the holy Lake Manasarowar, where the pilgrims worship.

Kanchenjunga, or Kinchinjunga (8,598 metres), the third highest mountain in the world, lies near Mount Everest, between Nepal and the Indian state of Sikkim. Other high peaks are Makalu I (8,481 metres); Makalu II (7,660 metres); Dhaulagiri (8,172 metres); Nanga Parbat (8,126 metres); and Mount Kamet (7,756 metres).

Passes and glaciers. The passes that run through the Himalaya are among the highest in the world. Few of the passes are lower than 4,600 metres above sea level. Most are covered with snow from November to May and are then impossible to cross. Many glaciers form in the high passes.

Climate and plant life. Almost every kind of climate can be found in the Himalaya because of the many different altitudes. This makes possible a variety of plant life. On the steep southern slopes grow tropical plants, such as fig and palm trees. These plants are found up to a height of 910 metres. Oak, chestnut, and laurel trees are common up to 2,100 metres. Deodar and pine trees begin to appear at 3,660 metres. Many shrubs and climbing plants are found in the forests. Rhododendrons grow on the mountain slopes. The tea plant is cultivated up to 1,500 metres. On the southern slopes, rice, maize, and millet are grown up to 1,800 metres. Wheat and barley are grown in slightly higher regions.

Animal life. The Himalaya has many animals that live in tropical, temperate, and cold regions. Tigers, leopards, rhinoceroses, elephants, yaks, and some kinds of monkeys are found there.

Related articles in ***World Book*** include:

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Mount Kanchenjunga
Mount Makalu
Nepal
Pamirs
Tibet
Yak

Himalayan balsam is a tall attractive plant with thick reddish, succulent stems and pinkish purple flowers spotted with crimson. The leaves are light green and oval-shaped. Himalayan balsam grows along the banks of canals, rivers, and streams throughout the Northern Hemisphere. It is native to northern India. An annual, Himalayan balsam can grow as high as 3 metres in its one year of growth. It is considered a weed in many places, because it takes over from the native vegetation. It is sometimes cultivated. See **Balsam.**

Scientific classification. Himalayan balsam belongs to the balsam family, Balsaminaceae. It is *Impatiens glandulifera.*

Himmler, Heinrich (1900-1945), was one of the most powerful leaders of Nazi Germany. As head of the German police, including the *Gestapo,* he ordered the deaths of millions of people (see **Gestapo**). The killings began with the "blood purge" of 1934, and ended with systematic killings in World War II concentration camps.

Himmler was born in Munich. He was a follower of Adolf Hitler from the days of Hitler's unsuccessful attempt to gain power in 1923. He became chief of police for all Germany in 1936, minister of the interior in 1943, and minister of home defence in 1944. He committed suicide after Allied troops captured him.

Hinckley and Bosworth (pop. 93,600) is a local government district in western Leicestershire, England. Its industries range from brick making, coal mining, and granite quarrying, to the production of steel tubes. Hinckley town has industries producing footwear, and a variety of clothing, including gloves, hosiery, and knitwear. Local farms produce grain and root crops. The district includes the site of the Battle of Bosworth Field. The battle took place in 1485. See **Bosworth Field.**

Hindemith, Paul (1895-1963), was a leading German composer and music theorist. Hindemith's compositions are noted for their use of music forms of the past and polyphonic melodies, as well as his own harmonic theories (see **Counterpoint**).

Hindemith wrote many sonatas for orchestral instruments, including such rarely featured instruments as the double bass, trombone, and tuba. He also wrote concertos for cello, clarinet, organ, piano, and violin, as well as concertos for such combinations of instruments as the trumpet and the bassoon. Hindemith's other orchestral works include seven pieces called *Kammermusik* (Chamber Music, 1922-1927) for various solo instruments and small orchestra. Hindemith's opera *Mathis der Maler* (1938) explores the role of the artist in society. The music was first performed as a symphony in 1934. Hindemith explained his system of music theory in *The Craft of Musical Composition* (1937, 1939, revised 1945).

Hindemith was born in Hanau. He taught at Yale University from 1940 to 1953 and became a United States citizen in 1946. While at Yale, he organized a *collegium musicum,* which is an association of musicians devoted to performing older music. This association made a significant impact on the revival of interest in early music.

Hindenburg. See **Airship** (The Hindenburg; picture).

Hindenburg, Paul von (1847-1934), was a German soldier and statesman. He was military leader of Germany during World War I (1914-1918), and he served as president of Germany from 1925 until his death. Hindenburg appointed Adolf Hitler chancellor in 1933.

Hindenburg was born in Posen, East Prussia (now Poznań, Poland). He served as a junior officer in Prussian military victories over Austria in 1866 and France in 1870 and 1871. Hindenburg became a general in 1896, and he retired in 1911. When World War I began, Hindenburg came out of retirement to command the German Eighth Army. General Erich Ludendorff became his chief of staff. In the autumn of 1914, Hindenburg and Ludendorff won important victories over Russian forces in East Prussia. Hindenburg was promoted to field marshal and became commander in chief on the eastern front. In 1916, he became supreme commander of all German forces, and one of the most powerful men in Germany. Ludendorff, whom many historians consider a better strategist, remained Hindenburg's second in command.

Early in 1917, Hindenburg and Ludendorff ordered the Siegfried Line built in northeastern France, to shorten the western front and to ease the strain on Germany's troops. Germany held this line from March 1917 until the Allies broke through at the end of the war in September 1918. The Allies called it the Hindenburg Line. See **World War I** (The final stage).

Paul von Hindenburg

Hindenburg was elected president of Germany in 1925, and was reelected in 1932. The Great Depression in 1929 caused unemployment and unrest in Germany and led to support for Hitler's Nazi Party. Hindenburg used his presidential power to keep Hitler out of power. But in the elections of 1932, the Nazi Party showed that it had become the strongest party in Germany. Hitler claimed the support of a majority of parliament.

The aged and tiring Hindenburg finally appointed Hitler chancellor on Jan. 30, 1933. After Hindenburg died in 1934, Hitler abolished the presidency and assumed its powers.

See also **Hitler, Adolf** (Rise of the Nazis; picture).

Hindenburg Line. See **Siegfried Line.**

Hindi is one of the official languages of India. More Indians speak Hindi than any other language. In a broader sense, the word *Hindi* refers to a group of languages spoken in north central India. Modern Hindi developed from a dialect called Khari Boli but includes elements of Sanskrit, an ancient Indian language. During the 1800's, when the British controlled much of India, they encouraged the Indians to systematize Hindi. Today, the Indian government promotes Hindi as a national language.

See also **India** (Languages); **Alphabet** (picture: Some important alphabets).

Hindmarsh, Sir John (1785-1860), a British naval officer, was the first governor of South Australia, from 1836 to 1838. He shared his responsibilities with the resident commissioner of the South Australian Colonization Commission. He disagreed with the commission's choice of a site for the new settlement of Adelaide. He began suspending public officers, and the British recalled him in 1838. Hindmarsh was born in Britain. He joined the navy in 1793, and fought at the battles of the Nile and of Trafalgar.

Hindu-Arabic numerals. See **Arabic numerals; Numeration systems** (History).

Hindu Kush is a chain of mountains in Central Asia. For the location of the Hindu Kush, see **Afghanistan** (map). The name *kush,* which means death, was probably given to the mountains because of their dangerous passes. The Hindu Kush were called the Caucasus by historians of Alexander the Great. The mountains are a westward continuation of a region called the Pamirs. See **Pamirs, The.**

For 800 kilometres, the Hindu Kush form a great *watershed,* or water divide, between the Indus and Amu Darya rivers. They are part of the boundary between eastern Afghanistan and northwestern Pakistan. Many of the mountains are over 7,000 metres. The highest peak in the range is Tirich Mir (7,690 metres). Tamerlane, a Mongol leader who lived in the 1300's, reportedly tried to cross these mountains.

Hinduism has numerous sacred writings, and its believers worship many gods and goddesses. The priests shown on the left are reading from the *Rig-Veda,* the oldest sacred book in Hinduism. On the right, Hindus pray before an image of the many-armed goddess known as Durga or Kali. This divinity is the wife of the god Shiva. She is worshipped as the feared goddess of destruction.

Hinduism, the major religion of India, is one of the oldest living religions in the world. It evolved in India. Most Hindus live in India, where 83 per cent of the population is Hindu. Hinduism in India affects family life, food, dress, and architecture. The caste system as applied to Hindus determines their way of life, often even their occupations. Hindus have settled throughout the world and have taken their faith with them. So Hinduism is found nowadays in many countries, and Hindu literature and philosophy have influenced people throughout the world.

Beliefs of Hinduism

The word *Hindu* is of ancient Persian origin. The Persians used the word to describe people who lived beyond the River Indus (called *Sindhu* in the ancient Sanskrit language) and their religion. Many Hindus themselves call their faith *Sanatana Dharma,* meaning the eternal or ancient religion. Hinduism includes the *Varna-ashrama-dharma.* This phrase refers to the duties of the four *varnas,* or social divisions, and the *ashramas,* or stages in life. Unlike other major religions such as Buddhism, Christianity, and Islam, Hinduism was not founded on the teachings of one person. It developed gradually over thousands of years. Many *sects* (groups) arose within Hinduism, and each developed its own philosophy and form of worship. Hinduism has many sacred books divided into *Shruti* (revealed or heard), and *Smriti* (remembered) texts.

Generally speaking, most Hindus believe in the authority of the *Vedas,* the oldest Hindu scriptures and the oldest sacred writings of any major religion. A Hindu also accepts the teachings of the *Dharma-Shastras,* or ancient law books, and the philosophical writings of the *Upanishads* and the *Bhagavad-Gita.* Most Hindus believe in a supreme spirit, called *Brahman,* and in the reincarnation of a person's *atman,* or soul. Hindus must practise *satya* (truth) and *ahimsa* (noninjury). They must respect other people's property. Every Hindu follows the *dharma* (religious and moral duty) of varna, *jati* (caste), *kula* (family), and ashrama as best they can. Hindus believe in life after death. An individual can follow various paths to achieve *moksha* (release from the cycle of birth and rebirth), and ultimate union with Brahman, or God.

Divinities. Early Hinduism was *polytheistic*—that is, the Hindus worshipped many gods. Early Hindu gods represented powers in nature, such as the rain and the sun. The Hindu idea of a supreme power, or God, evolved from the ancient writing of the *Rig-Veda* (as early as 1500 B.C.) to the early verse stories called the *Puranas* (from the 500's A.D.). The deities of the *Rig-Veda* represent natural forces. They include Indra (thunder), Agni (fire), Varuna (waters), Mitra (daylight), Rudra (storms), Ushas (dawn), Prithivi (earth), and the gods called the Adityas (light). Hindu philosophers believed that these gods were different forms of the supreme spirit. The philosophers of the *Upanishads* (begun in the 700's B.C.) named this supreme spirit *Brahman.*

Brahman was everywhere and had no form, quality, or gender. Such an abstract Brahman was beyond the understanding of ordinary people, so symbols, or images, were created to represent it in worship. Since Brahman is abstract, it can be represented as male or female; human or animal; or a combination of these. Many different images are used in modern Hindu worship. But images are only an aid to worship and not themselves objects of worship. They represent different aspects of Brahman. The three most important aspects of Brahman are Brahma, the Creator of the Universe; Vishnu, the Preserver; and Shiva, the Destroyer and Regenerator.

These three male deities are represented by a single image called the Trimurti. Their female consorts are respectively Saraswati, goddess of learning and the arts; Lakshmi, goddess of good fortune; and Shakti (also known as Parvati), the Mother Goddess. Shakti, in her destructive mood, is known as Durga or Kali. Other important deities of modern Hinduism are Ganesha, the elephant-headed god who removes obstacles; Hanu-

The god Shiva is known as the Lord of the Dance. The circle of fire around Shiva represents birth and rebirth.

man, the personification of devotion and strength; and Kartikeya or Subrahmanya, who is widely worshipped in south India. All these gods are aspects of Brahman.

Hindus believe that Vishnu, the Preserver, came down to earth in nine *Avatars,* or incarnations, to protect humankind; the tenth incarnation is still to come. The popular incarnations of Vishnu are Rama, the hero of the epic story *Ramayana,* and Krishna, the philosopher-god of the philosophical work, the *Bhagavad-Gita.* Despite seeming to have many gods, Hindus worship only one supreme spirit, in many forms and under different names.

Reincarnation. Hindus believe that the soul does not die with the body. They believe the soul is rehoused in a new body. When the body dies, the soul is reborn. This continuous process of rebirth is called *reincarnation.* Reincarnation depends on *karma* (a person's actions and their results). Every action influences how a person's soul will be born in the next incarnation. The soul goes through many existences in a cycle of births and rebirths called the *samsara.* Eventually, the soul can achieve a new level of existence, called *moksha,* when the soul is united with or comes as near as possible to the supreme spirit, Brahman. According to his or her capacities and natural inclination, a person may follow various paths to this goal.

The path of knowledge, *jnana,* involves deep study of the *Vedas* and the *Upanishads,* under the guidance of a learned teacher. Understanding the scriptures frees an individual from attachment to the material world and enables his or her soul to approach the supreme spirit.

The path of *yoga,* or discipline, involves the study of philosophy, meditation, and physical exercises to achieve bodily control, again with the help of a teacher. Yoga joins the spiritual force of the mind with the material forces of the body to give health, long life, and inner peace. Yoga liberates the soul from the cycles of successive lives.

The path of karma, or action, involves a person doing his or her religious and social duty with respect to varna, jati, ashrama, and family tradition, in a spirit of detachment. Karma includes all physical activity, as well as the result of a person's actions. If a person acts in expectation of selfish reward, his or her soul cannot progress. Hindus believe that selfless activity is the correct way to use human talent. All actions done as duty benefit both the individual and society, and lead the soul towards God.

Devotion and ahimsa. The path of devotion, *bhakti,* is for most individuals the easiest way to experience the supreme spirit. The follower of this path centres his or her devotion on a chosen personal deity *(ishwara);* offers worship to the image of the deity; chants the deity's name constantly; and serves others by doing good deeds in the deity's name. The ultimate goal is to let the soul merge into the spirit of God.

Ahimsa means noninjury, and in Hindu ethics is an important virtue. To practise *ahimsa* ideally, a Hindu must avoid all physical, mental, emotional, and moral hurt to any living creature. Because Hindus believe that animals as well as human beings have souls, they have reverence for cows, monkeys, and other animals. They have special reverence for cows.

A devout Hindu's life is divided into four ashramas, though in practice women usually share in only the second and third. Ideally, each stage brings its own special duties. The ashramas are: *brahmacharya* (student), *grihastha* (householder), *vanaprastha* (retirement), and *sannyas* (renunciation). The fourth *ashrama* is optional, and only men can become *sannyasins,* though these days a few women are also claiming the right to take *sannyas.*

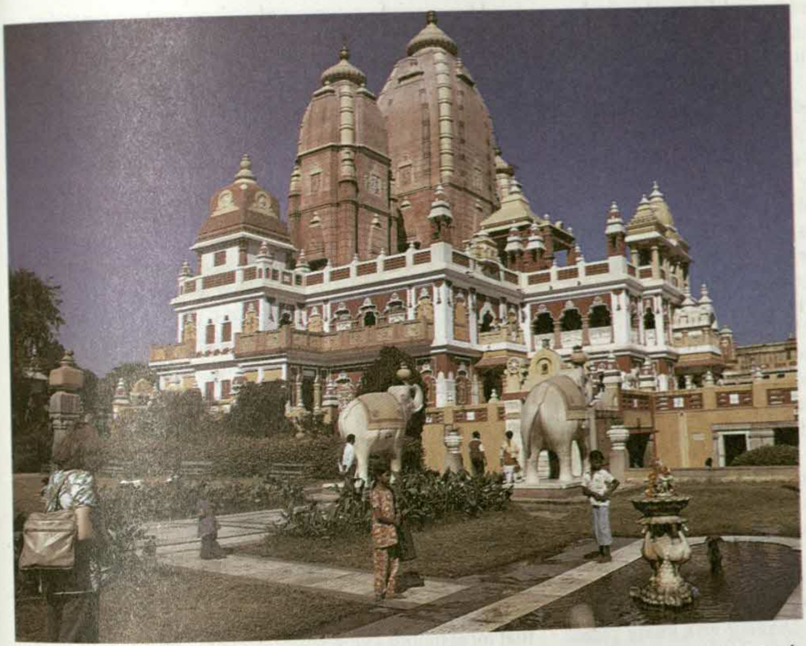
From about 500 B.C., Hindus have upheld four aims in life. These provide a value system for each individual. *Dharma* (religious and social duties) is the most important. It governs the other three: *artha* (earning a livelihood by honest means), *kama* (enjoying the good things in life in moderation), and *moksha* (leading the soul towards God and achieving release from the cycle of rebirths). Even the burden of *karma* does not bind the soul if actions are performed selflessly and according to dharma.

The six schools of philosophy. Many schools of Hindu thought have developed in India. The six most prominent schools are (1) *nyaya,* (2) *vaisheshika,* (3) *samkhya,* (4) *yoga,* (5) *purva-mimamsa,* and (6) *vedanta.*

Nyaya deals with logic. Vaisheshika concerns the nature of the world. Samkhya examines the origin and evolution of the universe. Yoga is a set of mental and physical exercises designed to free the body so that the soul can unite with Brahman. Both purva-mimamsa and vedanta interpret the *Vedas.*

Hinduism in daily life

Social divisions. India has an ancient system of social divisions called *varna,* which may have existed even before the references to it in the *Vedas.* The word *varna* in Hinduism signifies a social category. Originally society was divided into three categories: the white varna—*Brahmins* (priests and scholars); the red varna—*Kshatriyas* (rulers, administrators, soldiers); and the yellow



Lakshmi, goddess of good fortune, is honoured in this Hindu temple in Delhi, India's capital city.

varna—*Vaisyas* (peasant-farmers and merchants). But these divisions were not rigid. Later a fourth category was added: the black varna, which included *Sudras.* These were skilled artisans such as potters, weavers, and basket-makers, and servants.

With the evolving of a more complex society, these social divisions became rigid, and a fifth category of people emerged, ranking below the Sudras. These people did the dirtiest jobs. The upper varnas treated them badly and even avoided touching them. These *panchamas* (fifths) or "untouchables" were the most oppressed people in society. Untouchability was abolished by law in India in 1950. The Indian leader and teacher Mahatma Gandhi named the untouchables *Harijans* (children of God), but they prefer to call themselves *dalit* (depressed).

The countless castes of India probably began as occupational groups. They were gradually placed within the *varna* system, and ranked according to the dignity of work done. Originally each caste had specific duties, but today people from the different castes do jobs very different from their traditional occupations. In modern

Krishna with his wife Radha, are shown in this Punjabi painting of the 1700's.

A Hindu woman worships the god Brahma in this illustration made in the 1600's.

Hindus seek aid from Ganesha the elephant-headed god, before beginning a project.

times, the caste system has weakened. Educated Hindus nowadays mix freely with people from different castes. But caste continues to be an influence on Indian life. See **Caste.**

Food in Hinduism. In Hinduism the word "pollution" includes both physical, and spiritual or ritual impurity. This philosophy affects many aspects of social and religious practice, and especially food.

In middle-class Hindu families of the three upper varna, the kitchen is the purest part of the home. Food is prepared there and the household shrine is situated there. The person doing the cooking must have a bath and wear clean clothes. Only the right hand is used in the preparation and eating of food. Different foods are served on separate plates. Cooked food which has been touched by a member of a lower caste is considered polluted. Food touched by another person's lips is considered polluted. Certain foods like meat, poultry, and fish, and alcoholic drinks also cause ritual pollution.

Death in a family puts blood relatives of the deceased person in a state of ritual pollution. Food touched or cooked by them passes on their ritual pollution to others.

Hindus use water for personal purification, both physical and ritual. Running water is "pure", but stagnant water or water touched by someone from a lower caste is considered polluted.

Food cooked in water is *kacha* and becomes easily "polluted." Such cooked food is not accepted from a member of a lower caste. Food well fried in *ghee* (clarified butter) is *pukka* food. A Brahmin can accept such food from another person of a close caste but not, for example, from a Sudra.

A saddhu, or Hindu holy man, devotes his life to meditation and religious practices.

Fasting. Fasting, to a Hindu, does not always mean going without food. Food prepared from wheat, rice, millet, or *pulses* (beans) cannot be eaten during fasting, and "fasting food" is less tasty than the normal vegetarian diet. Special dishes are associated with some Hindu festivals, and food offerings are important in worship.

Village Hinduism. The practice of Hinduism differs widely throughout India. Middle-class Hindus living in towns behave differently from Hindus living in villages. In India, many more Hindus live in villages than in towns and cities. Villages differ, yet some common features distinguish village Hinduism from urban Hinduism in India.

A village population in India is usually made up of one or two Brahmin families, and some service castes such as barber, washerman, potter, and leather worker. The majority of villagers, though, are farmers, of land-owning castes. The village has a temple dedicated to the local guardian deity.

Village deities are minor gods, but they are less remote than the major deities. The guardian deity is often female. The villagers call her Mata, Ma, Amba, Amma, or some other name meaning "mother". Villagers believe that local deities can answer prayers and solve problems. Villagers refer to Brahman as "Bhagwan."

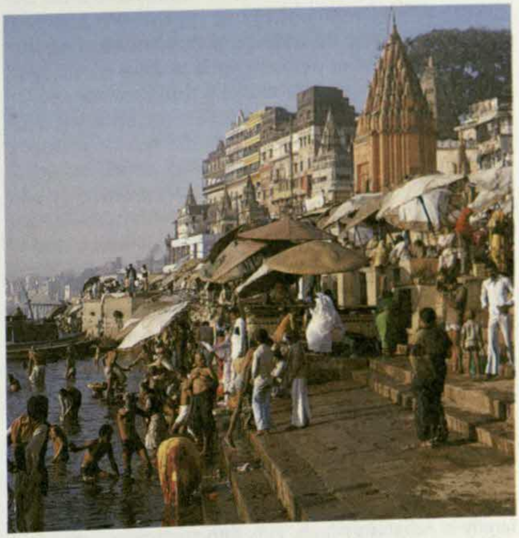
In large villages, people celebrate the annual festival of the guardian deity with a fair. Ritual offerings are made to the deity by the most important man in the village. Villagers make offerings of food, fruit, and sometimes chickens, to the mother deity to thank her for the rains, for curing a sick child or an animal, and for protecting the village.

Hindu worship

Hindus offer daily worship to family deities at the household shrine. They celebrate annual festivals dedicated to different deities, and they go on pilgrimages to distant shrines dedicated to Vishnu, Shiva, or the goddess Shakti. Broadly speaking, Hindus can be divided into three groups: those worshipping Vishnu in his various incarnations; those worshipping Shiva; and those worshipping Shakti. Hinduism has many sects, or groups, and each has its own form of worship. In some sects, a human *guru,* or spiritual teacher, is revered with the same fervour as a deity.

Hindu worship takes different forms. Ways of worshipping include offering water to the rising sun or a river deity; sitting cross-legged in front of an image in a temple and saying the name of the deity; walking around the shrine of a deity in a clockwise direction; or singing hymns in a temple. The most common form of worship is called *puja.* People make offerings of red kum-kum and yellow turmeric powders, rice grains, sandalwood paste, flowers, fruit, incense, and light to an image, either at the home-shrine or at a temple. Puja is offered to the family deities each morning after bathing. A more elaborate puja is performed at times of festivals. Food and fruit are offered to the deity at puja and received back after they are blessed. This blessed offering is called *prasad.*

Daily puja in a Hindu temple is conducted by the chief priest and his helpers. After the morning and



Festivals play an important part in Hindu life. People gather to make offerings *(left)* in the Bhai Dooj Festival at Varanasi. Many thousands travel to the city of Varanasi to bathe in the sacred waters of the River Ganges *(below)*.

evening puja, the sacred light called the *arati* is brought into the hall of the temple. Worshippers receive the light and place offerings of money in the arati tray.

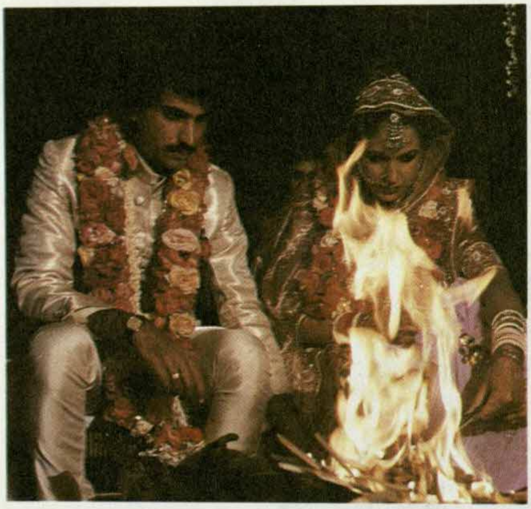
Pilgrimages. Hindus go on pilgrimages to distant temples to view the image of God and to offer worship, or to fulfil a vow. There are many centres of pilgrimage throughout India dedicated to Vishnu, Shiva, or the Mother Goddess. Important places of pilgrimage for Hindus are Badrinath in the Himalaya, Mathura on the River Jumna, Varanasi on the River Ganges, Puri in Orissa, Tirupathi and Kanchipuram near Madras, Madurai in Tamil Nadu, and Rameshwaram and Kanya Kumari at the southern tip of India.

Festivals. Hindu festivals are colourful, joyous occasions. They are celebrated either as private worship at a household shrine or as public neighbourhood festivals. Everyone in the neighbourhood takes part in the public festival, but the celebrations at home are restricted to each family and close friends. Some festivals such as Raksha-Bandhan, Diwali, Navaratri, Dusserah, and Holi attract large crowds all over India. Other festivals such as Durga-Puja, Saraswati-Puja, Naga-Panchami, and Ganesha are more regional in their popularity. Every large temple celebrates the annual festival of the deity to which it is dedicated. At this time a replica of the main image is taken in a chariot procession, called *ratha-yatra,* through the town. The processions at Jagannath Puri and Udipi are famous for their colourful pageantry.

Navaratri is the Nine Nights festival dedicated to the goddess Shakti. On the eighth night, Durga-Puja is celebrated as a public festival in Bengal. On the day after Navaratri is Dusserah, the climax of the Rama-Leela festival in north India. It commemorates the exploits of Prince Rama, as described in the epic *Ramayana.* Twenty days after Dusserah, usually in October or November, comes the festival of Diwali, dedicated to Vishnu and his consort Lakshmi. On the Raksha-Bandhan day, in August, women tie a silk thread round the wrists of their brothers to renew ties of affection. Holi is celebrated towards the end of the Hindu calendar year, with a bonfire and merry-making. People worship Saraswati in a public festival in Bengal. In August in western India, Hindus in rural areas worship live snakes on the day of Naga-Panchami.

In Maharashtra in western India, the Ganesha (or Ganapati) festival is celebrated for ten days in many towns and cities. A large clay image of the deity is installed in a temporary pavilion, and puja is offered morning and evening. Recitals of Indian classical music, folk song contests, and plays are arranged as entertainment. On the last day, images from the different localities are taken in procession to the local river, and immersed in the water.

Hindu life-rituals. Hindus perform rituals at important stages of development in life. Hindus believe these rituals purify the body and ennoble the personality. The ancient Sanskrit word for such a ritual is *samskara,* meaning sacrament. There are 16 samskaras recommended in the *Dharma-Shastras,* or ancient law books,



A Hindu wedding ceremony lasts several days and is conducted by the village priest.

but only a few people undergo all of them. Most well-to-do Hindu families perform some of these rituals, but only boys experience the sacred thread ceremony. Three samskaras are performed during pregnancy; after the birth of a baby come six childhood sacraments: to mark the birth, the naming of the child, its first outing, first solid food, first hair cut (also experienced by girls in south India), and earlobe piercing. The tenth, and initiation, sacrament is called the *upanayana,* when boys of the three upper varnas are invested with a sacred thread before they begin their study of the scriptures and start formal education. The next two sacraments are included symbolically in the thread ceremony. The 13th samskara is *vivaha,* or marriage. The 14th is the householder stage, and the 15th is the so-called forest-dwelling stage when a special puja is performed after a person retires from regular employment on the 60th birthday. The 16th and final sacrament is cremation of the dead.

The *upanayana* sacrament is important as the "second-birth" of a boy. After this ritual, he can represent his family in religious rituals. Worship and prayers are offered to *Agni* (sacred fire) to endow the boy with strength and understanding. Worship is also offered to the Sun so that the boy may have intelligence to study the scriptures. The boy is then taught the *Gayatri-Mantra* from the *Rig-Veda* scriptures. (A mantra is a sacred utterance, often a single syllable.)

Fifteen different rituals are performed in a Hindu marriage ceremony. The most important one is the *saptapadi,* or seven-steps, which the couple take near the sacred fire at the time of their marriage vows.

Hindus cremate their dead. The funeral pyre is lit either by the eldest or the youngest son of the deceased person. The son also has a religious duty to perform *shraddha,* a ritual in annual remembrance of deceased parents or grandparents.

Literature

Hinduism has no single book that serves as the source of its doctrines. But Hinduism has many sacred writings, all of which have contributed to its fundamental beliefs. The most important of these writings include the *Vedas,* the *Puranas,* the *Ramayana,* the *Mahabharata,* and the *Bhagavad-Gita.*

The Vedas. The teachings of the Vedas existed for centuries before they were finally written down. There are four *Vedas*—the *Rig-Veda,* the *Sama-Veda,* the *Yajur-Veda,* and the *Atharva-Veda.* Each has four parts—the *Samhitas,* the *Brahmanas,* the *Aranyakas,* and the *Upanishads.* The *Samhitas* contain prayers and hymns, and are the most important part. The *Brahmanas* deal with ritual and theology, and include explanations of the *Samhitas.* The *Aranyakas* deal with the philosophy of devotion for hermits and saints. The *Upanishads* are works of philosophy written as dialogues.

The Puranas are long verse stories that contain many important Hindu myths about Hindu gods and goddesses and the lives of great Hindu heroes. They also describe the Hindu beliefs about how the world began and how it periodically ends and is reborn. There are 18 important *Puranas.* The *Bhagavata Purana* is the most widely read text for the worshippers of Vishnu.

The Ramayana and the Mahabharata are long epics. The Ramayana tells the story of Prince Rama and his attempts to rescue Sita, his wife, who has been kidnapped by the demon king Ravana. The *Mahabharata* describes a battle between the Pandavas and the Kauravas, two families who are cousins.

The *Bhagavad-Gita,* a philosophical work, forms part of the *Mahabharata.* In it, the god Krishna and the Pandava warrior Arjuna discuss the meaning and nature of existence.

Hindu funeral ceremonies involve cremation, or burning the body on a wood fire.

The *Dharma-Shastras* are books on Hindu law and custom. The important ones are those written by Manu, Yajnavalkya, Parashara, and Narada.

Philosophical ideas. *Vedanta* philosophy and the *Bhagavad-Gita* define *atman* as the divine energy in every creature. Atman, the soul, continues to exist when the body dies, when it is rehoused in a new body. Each atman, because of its karma, experiences many lives until it achieves moksha. The philosopher Shankara held that atman and Brahman were identical. Ramanuja maintained that atman does not merge with Brahman when it achieves liberation. Madhava stated that atman and Brahman were quite separate. Hindu philosophers teach that three qualities, *prakriti* (the matter necessary for all creation), *gunas* (the attributes built into the character of every created object), and *maya* (which makes this impermanent world appear merely as an illusion) bind atman to the material world. It is trapped in the cycle of successive lives.

History

Excavations in the Indus Valley in the 1920's revealed the existence of an ancient civilization which flourished between 3000 and 2000 B.C. at Mohenjo-Daro and Harappa, now in Pakistan. The ancient Indus Valley people probably worshipped a Mother Goddess and a male deity, the forerunner of Shiva in later Hinduism. When tribes speaking an Aryan language settled in northwest India in about 1500 B.C., the Indus cities were probably in decline. The new settlers probably adopted some religious ideas from the earlier inhabitants and incorporated them into their rituals.

The Aryan-speakers worshipped spirits of nature. What is known of their religion comes from the hymns of the *Rig-Veda,* composed in stages from around 1500 B.C., which praise the spirits controlling natural forces. The Vedic deities were mostly male, and the Mother Goddess concept may have been taken from the Indus Valley people. Among the Vedic deities, Indra, Mitra, and Varuna were important, along with the Adityas, Rudra, and Prajapati. In time the first three gods were forgotten but the others gave rise to the Trimurti of modern Hinduism. Prajapati became Brahma, Rudra became Shiva, and one of the Adityas became Vishnu. These gods came to be represented as a single image.

The *Upanishads* are the earliest books of Hindu philosophy, and were begun over 2,700 years ago. During the next 2,000 years, important compositions like the ancient law books, the epics *Ramayana* and the *Mahabharata,* and the *Puranas* firmly established the Hindu tradition in India. Each of these texts was compiled over hundreds of years.

Hindu reform movements. After 1498 when the Portuguese navigator Vasco da Gama sailed to India from Portugal, Indians came into contact with Western seamanship, science, European (and particularly English) literature, and European Christian missionaries. The British eventually became the dominant European power in India. From the 1700's, the British East India Company employed Indians in large numbers as clerks, minor revenue officials, and common soldiers. Contact with very different and challenging cultural patterns gave rise to new ideas in India, which resulted in important Hindu reform movements in the 1800's.

Ram Mohan Roy (1772-1833) was born into a Brahmin family in Bengal and experienced the orthodox practice of Hinduism in his youth. He studied the Quran, Buddhism, and the New Testament. He disliked image worship and hated the practice of suttee ever since the time he saw his brother's widow burned alive on her husband's funeral pyre. He fought to abolish polytheism, image worship, the caste system, child marriage, animal sacrifice, and suttee.

In 1828 he founded the Brahmo Samaj (Society of Brahma (God)), in an attempt to reform Hindu religious practice. The hall of worship of the Samaj had no images, statues, or pictures. Only prayers and hymns affirming One God were selected. Members offered worship as a group. This *congregational* form of worship was new to Hinduism. The form of worship adopted by the Brahmo Samaj was based on the Christian way of worship, since the founder was inspired by Western ideas.

The Samaj inspired progressive development in Hindu society, religion, and politics. The various important laws passed between 1829 and 1950 concerning suttee, caste disabilities, Hindu widows' remarriage, child marriage, women's property, and untouchability were indirect results of the reform movement of Ram Mohan Roy.

Dayananda (1824-1883) founded the Arya Samaj in 1875. Dayananda was born in Gujarat, into a rich Brahmin family who worshipped Shiva. He was invested with the sacred thread at the age of eight. Three years later, when he was keeping vigil in a Shiva temple at night, he saw that rats appeared from the holes in the walls and began to eat the food offered to Shiva. He began to doubt the deity's power and formed a dislike for image worship. When his parents arranged his marriage he left home. From the age of 20 he travelled widely to meet holy men to widen his knowledge of religion and philosophy. He studied the Vedas for three years at Mathura until 1863. When his studies were completed, his teacher charged him with the duty of spreading the Vedic faith.

In 1875 Dayananda founded the Arya Samaj (Society of Aryans). He claimed the Vedas to be eternal, infallible, and a complete revelation of God. He accepted the doctrines of *karma* and rebirth, but opposed image worship, polytheism, animal sacrifice, caste based on birth, untouchability, pilgrimages, and ritual bathing. He condemned child marriage and the segregation of women, but opposed the remarriage of widows. He introduced "purification rites" to reconvert those Hindus who had been converted to Christianity or Islam. Arya Samaj followers worship on Sundays. They make offerings to Agni (fire) while reciting the Gayatri Hymn from the *Rig-Veda,* and read, preach and teach the Vedas. There is no image worship. The Samaj is a democratic organization without regular priests. Every member is required to practise austerity, truth, and devotion to God.

Modern Hinduism is developing in many ways. There are several modern examples of sectarian worship such as the International Society for Krishna Consciousness (the Hare-Krishna Movement); the Swaminarayan Religion; and the Sathya Sai Baba Movement. These forms of Hinduism lay great emphasis on worship through *bhakti* (devotion).

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Jagganath
Karma
Mahabharata
Manu
Ramanuja
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Religion (picture)
Religious life (Hinduism)
Sculpture (pictures: The Hindu goddess Durga; The Hindu god Shiva)
Shankara
Shiva
Upanishads
Vedas
Vishnu
Yoga

Questions

What are the oldest Hindu scriptures?
Why is the kitchen an important part of a Hindu household?
How was early Hinduism *polytheistic?*
What is *puja?*
What name is given by Hindus to the supreme spirit?
Which Hindu deity is known as the Preserver?
What does a Hindu mean by *ahimsa?*
What do Hindus believe happens to the soul after death?
How many Hindu life-rituals are there?
How has Hinduism influenced social divisions in India?

Hines, Earl (1905-1983), was an American jazz pianist. He became known for his inventive and witty piano style, featuring strong octaves and single "trumpet-style" notes played by the right hand.

Earl Kenneth Hines was born in Duquesne, Pennsylvania. He acquired the nickname of "Fatha" early in his career. During the late 1920's, he made a series of recordings with trumpeter Louis Armstrong that rank among the masterpieces of jazz. Hines led one of the most exciting jazz bands of the 1930's. In the 1940's, he led a famous band during the *bebop,* or *modern,* period of jazz. This band included trumpeter Dizzy Gillespie and alto saxophonist Charlie Parker. From the 1950's to the early 1960's, Hines remained active as a bandleader, but his work gained little national attention. He made a comeback during the mid-1960's and then led combos that featured him as soloist.

Hinkler, Bert (1892-1933), an Australian aviator, made the first solo flight from Britain to Australia in 1928. He made the flight in a single-engined Avro Avian aircraft in 15½ days. After the flight, which broke five aviation records, the Australian government gave him a grant of £2,000 and made him an honorary squadron leader.

Louis John Hinkler was born at Bundaberg in Queensland. As a boy, he studied the flight of ibises. Later, he tried to fly by strapping wings to his back. At the age of 19, he successfully flew his homemade glider to a height of 10 metres at Mon Repos beach. He became a mechanic and pilot with a showman and gave flying exhibitions in Australia and New Zealand. The plane used in the exhibitions was eventually smashed beyond repair.

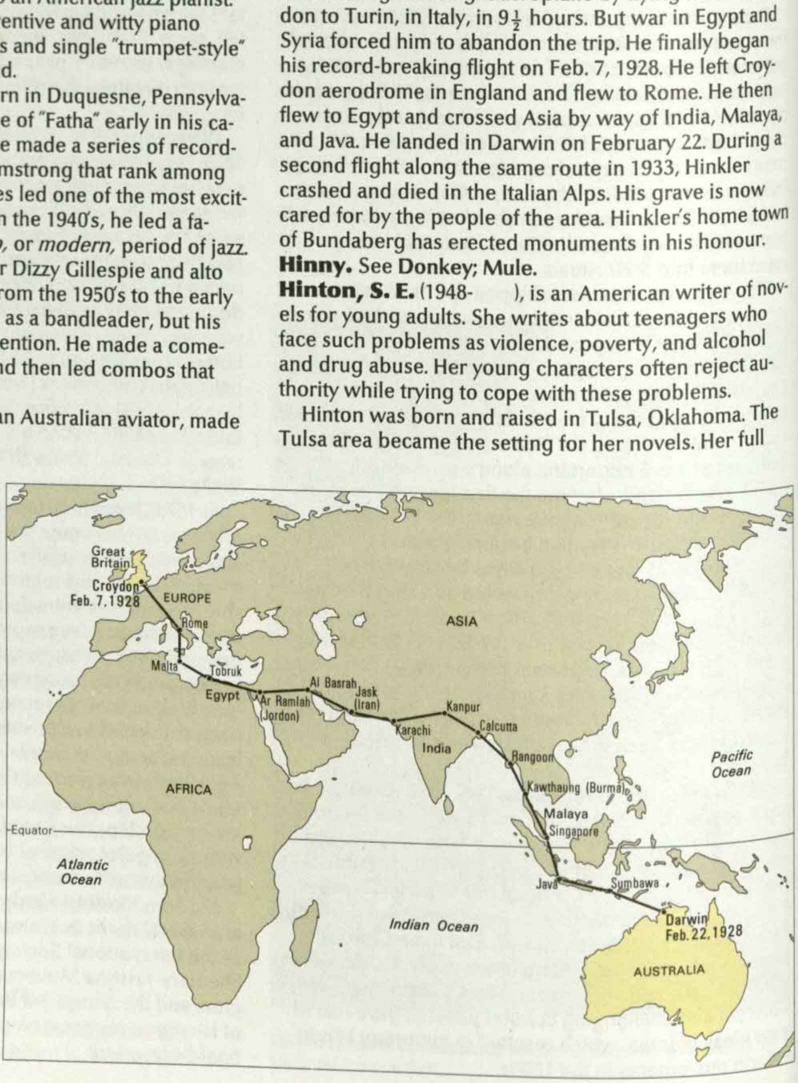
At the age of 21, Hinkler went to England and joined the Royal Naval Air Service as an observer-gunner. He won the Distinguished Service Medal in France. He also served as a pilot in Italy.

In 1919, Hinkler joined A.V. Roe as a mechanic and finally managed to obtain a plane to fly to Australia. He set out on May 31, 1920. He set a new record for a long-distance flight in a light aeroplane by flying from London to Turin, in Italy, in 9½ hours. But war in Egypt and Syria forced him to abandon the trip. He finally began his record-breaking flight on Feb. 7, 1928. He left Croydon aerodrome in England and flew to Rome. He then flew to Egypt and crossed Asia by way of India, Malaya, and Java. He landed in Darwin on February 22. During a second flight along the same route in 1933, Hinkler crashed and died in the Italian Alps. His grave is now cared for by the people of the area. Hinkler's home town of Bundaberg has erected monuments in his honour.

Hinny. See **Donkey; Mule.**

Hinton, S. E. (1948-), is an American writer of novels for young adults. She writes about teenagers who face such problems as violence, poverty, and alcohol and drug abuse. Her young characters often reject authority while trying to cope with these problems.

Hinton was born and raised in Tulsa, Oklahoma. The Tulsa area became the setting for her novels. Her full



Bert Hinkler made the first solo flight from Britain to Australia in 1928. He left the Croydon aerodrome on February 7 and landed in Darwin on February 22. Hinkler flew a single-engined Avro Avian aircraft across Europe, northern Africa, the Middle East, India, Malaya, and Indonesia. The historic flight broke five aviation records. In 1933, Hinkler began a second solo flight along the same route, but he died when his plane crashed in the Italian Alps.

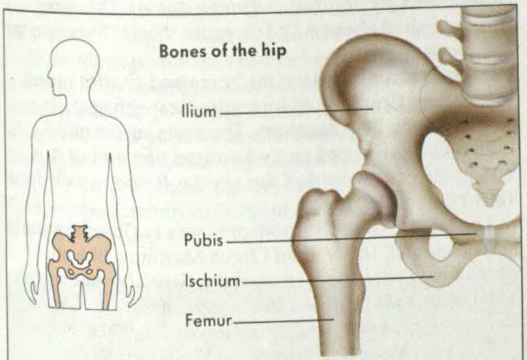
name is Susan Eloise Hinton. Hinton's first and probably best-known book is *The Outsiders,* written when she was 16 and published in 1967. It is a story about two rival gangs, one rich and one poor. The book is noted for its action-packed plot, believable characters, and realistic language.

Hinton's second novel, *That Was Then, This Is Now* (1971), focuses on teenage boys and the problems of growing up, especially the problem of drug abuse. *Rumble Fish* (1975) tells the story of a 14-year-old boy who idolizes his older brother, a former gang leader. His efforts to be like his brother get him into serious trouble. *Tex* (1979) also deals with two brothers, aged 14 and 17. Their father abandons them, and tensions grow between them as the younger brother tries to become more independent.

Hip is the region of the body between the trunk and the thigh. The hip joint is formed by the hipbone (which consists of three united bones, the *ilium, ischium,* and *pubis*) and the head of the *femur* (thighbone). The head of the femur fits into the *acetabulum,* a socket in the hipbone. This arrangement forms a ball-and-socket joint, which provides great strength and allows a wide range of motion in all directions. Several powerful muscles surround the joint, including the large, round *gluteus maximus* at the back; the *gluteus medius* on the side; and the long, straplike *rectus femoris* in front. These muscles make the joint firm so a person can stand. They also move the leg for walking and running.

Many children are born with a hip socket that is too shallow. This condition is called *congenital dislocation of the hip.* In old age, the neck of the femur, located just below the head of the femur, becomes weak and breaks easily. The break can be repaired by fastening the head on the neck with a stainless steel pin. Many arthritis victims suffer disabling pain in the hip joint. In such cases, the joint can be replaced by a plastic socket and a metal ball.

See also **Human body** (Trans-Vision picture).



The hip joint is a ball-and-socket arrangement that permits a wide range of movement in all directions. The illustration above depicts the bones of the hip joint and their attached muscles.

Hipparchus (180 B.C.?-125 B.C.?), an ancient Greek astronomer, discovered the *precession* (movement) of the equinoxes. Excited by the appearance of a new star, he studied earlier observations and noticed that the stars had shifted eastward. He found that while their celestial longitude increased slightly, their latitude did not change. He explained these facts by a slow forward motion of the equinoxes. See **Equinox.**

Hipparchus drew up the first catalogue of the stars, showing their brightness and position, and marked them on a celestial globe. He distinguished between two different lengths (tropical and sidereal) of the year. From his observations of the unequal length of the year's four seasons, he derived an improved description of the sun's movement. He used mathematics, especially plane trigonometry, in his work. See **Magnitude.**

Hipparchus was born in Nicaea. Only one of his writings, a commentary on an astronomical poem, still exists. His technical treatises have all been lost. Ptolemy, the foremost ancient authority on astronomy, absorbed everything of value in the treatises (see **Ptolemy** [Astronomer]).

Hipparchus (? -514 B.C.) was a son of Pisistratus, a ruler of Athens in the 500's B.C. Hipparchus came to power with his brother Hippias in 527 B.C., after the death of their father. But Hipparchus left government matters to his brother and concerned himself with cultural affairs. He brought such poets as Anacreon and Simonides to Athens. Hipparchus was killed by two young nobles, Harmodius and Aristogeiton. Another Athenian named Hipparchus was a relative of Pisistratus. He was elected archon, or chief magistrate, in 496 B.C.

Hippies were members of a youth movement of the 1960's and 1970's that started in the United States and spread to Canada, Great Britain, and many other countries. The hippies rejected the customs, traditions, and life styles of society and tried to develop those of their own. Most hippies came from white middle-class families and ranged in age from 15 to 25 years old. They thought too many adults cared about making money and little else. The term *hippie* may come from the word *hip,* which means *"tuned-in"* or *aware.*

Hippies wanted a world based on love of humanity and peace. Many believed that wonderful, magical changes were about to take place. They thought these changes would happen as soon as people learned to express their feelings honestly and to behave naturally at all times.

Many hippies lived together in small groups, working with one another and sharing possessions. Others refused to be tied down to a fixed job or home. They wandered from place to place seeking part-time work and temporary shelter. Some begged for spare change and lived in the streets or camped in parks or other public lands.

Hippies were sometimes called "flower children" because they gave people flowers to communicate gentleness and love. They let their hair grow long and walked barefoot or in sandals. Hippies attracted public attention by wearing clothing that featured unusual combinations of colours and textures. A large number of hippies used marijuana, LSD, and other drugs. Drug experiences shaped many of their symbols and ideas.

The Beatles, a popular English rock group, helped spread the hippie movement with their songs. Hippie favourites included such other rock groups as the Grateful Dead and the Jefferson Airplane, singers Joan Baez and Bob Dylan, poet Allen Ginsberg, and novelist Ken Kesey. Many hippies admired Timothy Leary, a psychologist who preached salvation through the use of drugs.

In time, most hippies realized it was not easy to reform society by "dropping out" of it. Some joined more organized political movements to work for specific social causes. Others turned to spirituality or religion. The majority simply left the hippie stage of their lives behind while trying to hold on to at least a few of the ideals that once inspired them.

See also **Baez, Joan; Beatles; Ginsberg, Allen.**

Hippocampus. See **Seahorse.**

Hippocrates (460?-380? B.C.) was a well-known ancient doctor who practised medicine on the Greek island of Cos. Long after his death, Hippocrates became the most famous person in ancient medicine. His fame probably resulted from about 80 anonymously written medical works that became part of the collection of the Library of Alexandria after about 200 B.C. Those writings became linked with Hippocrates and are known by scholars as the *Hippocratic corpus.* However, none of these "Hippocratic" works can be proved to have been written by Hippocrates.

The Hippocratic oath

I swear by Apollo Physician and Asclepius and Hygieia and Panaceia and all the gods and goddesses, making them my witnesses, that I will fulfil according to my ability and judgment this oath and this covenant:

To hold him who has taught me this art as equal to my parents and to live my life in partnership with him, and if he is in need of money to give him a share of mine, and to regard his offspring as equal to my brothers in male lineage and to teach them this art—if they desire to learn it—without fee and covenant; to give a share of precepts and oral instruction and all the other learning to my sons and to the sons of him who has instructed me and to pupils who have signed the covenant and have taken an oath according to the medical law, but to no one else.

I will apply dietetic measures for the benefit of the sick according to my ability and judgment; I will keep them from harm and injustice.

I will neither give a deadly drug to anybody if asked for it, nor will I make a suggestion to this effect. Similarly I will not give to a woman an abortive remedy. In purity and holiness I will guard my life and my art.

I will not use the knife, not even on sufferers from stone, but will withdraw in favour of such men as are engaged in this work.

Whatever houses I may visit, I will come for the benefit of the sick, remaining free of all intentional injustice, of all mischief and in particular of sexual relations with both female and male persons, be they free or slaves.

What I may see or hear in the course of the treatment or even outside of the treatment in regard to the life of men, which on no account one must spread abroad, I will keep to myself holding such things shameful to be spoken about.

If I fulfil this oath and do not violate it, may it be granted to me to enjoy life and art, being honoured with fame among all men for all time to come; if I transgress it and swear falsely, may the opposite of all this be my lot.

The Hippocratic Oath, No. 1 of the *Supplements to the Bulletin of the History of Medicine,* copyright 1943. Text, translation, and interpretation by Ludwig Edelstein.

Hippocrates is often called the father of medicine. This image of him emerged from the writings of Galen, a great doctor who lived during the A.D. 100's and 200's. Galen believed that the life and practice of Hippocrates represented all that was good in medicine. For example, a Hippocratic tract called *Nature of Man* maintained that illness was caused by an imbalance of four *humours* (liquids) in the body—blood, black bile, yellow bile, and phlegm. This belief dominated theories of disease until the late 1800's. To Galen, the *Hippocratic oath* served as a model for the ethical practice of medicine. On qualifying medical students still take an oath modelled on this text.

Hippocratic medicine challenged the methods of many doctors who used magic and witchcraft to treat disease. It taught that diseases had natural causes and could therefore be studied and possibly cured according to the workings of nature. Under Hippocratic medicine, a well-trained doctor could cure illness with knowledge gained from medical writings or from experience. Modern medicine is still based on this assumption.

Little is known for certain about Hippocrates' life. So-called facts about his birth, medical practice, and death are more attributable to myths or legends than to actual evidence. The earliest known biography of him is *Life of Hippocrates,* by Soranus, a Roman doctor. This work was published about A.D. 100, more than 400 years after Hippocrates' death.

Hippodrome is a place for horse and chariot races. The ancient Greeks built hippodromes with seats in rows, or tiers, like bleachers. The seats surrounded a long race course, and curved around one end of it. A wall in the centre divided the course. It was usually from 180 to 240 metres long.

The largest Greek hippodrome was in Constantinople (now Istanbul). The Roman Circus Maximus, like all Roman circuses, was a copy of the Greek hippodromes. The Circus Maximus was the largest of the ancient Roman hippodromes. It seated about 250,000 spectators.

In more recent times, race tracks, indoor circuses, and other amusement places have been called hippodromes.

Hippolyta. See **Amazons.**

Hippopotamus is the third largest animal that lives on land. Only the elephant and rhinoceros are larger. A large, wild river hippopotamus may weigh over 2,500 kilograms.

Hippopotamuses live in central, southern, and western Africa. They live close to water and spend much time in it. The word *hippopotamus* comes from two Greek words meaning *river horse.* However, the hippopotamus is more closely related to the pig than to the horse. There are two kinds of hippopotamuses: (1) the *river hippopotamus,* also called the *common hippopotamus,* and (2) the *pygmy hippopotamus.* The pygmy hippopotamus is much smaller than the river hippopotamus. It is also rarer.

The body of a river hippopotamus. The river hippopotamus has a large, barrel-shaped body; short legs; and a huge head. It weighs from 1,100 to 1,400 kilograms and stands about 1.5 metres tall. It ranges from 4 to 5 metres long, not including the tail, which measures about 55 centimetres. Each foot has four webbed toes.

The eyes of the river hippopotamus stick out from its head. The position of the ears, eyes, and nostrils enables the animal to hear, see, and breathe with most of its head under water. The hippopotamus can also close its nostrils and ears when it swims or dives. Hippopotamuses have a good sense of smell, but their vision is only fair.

River hippopotamuses have thick, brownish-grey skin. They have no hair except for a few bristles on the head and tail. Special glands in the skin give off a clear, oily fluid that is either pink or red. This fluid keeps the animal's skin from getting too dry. The reddish colour of the fluid led to the mistaken belief that hippopotamuses sweat blood.

A hippopotamus has long, curved front teeth. Its tusklike *canines* (side teeth) are even longer. All the teeth grow throughout the animal's life. But they seldom become too long, because the teeth of the upper and lower jaws grind together and wear each other away. The canines of a hippopotamus may grow more than 60 centimetres long, but only about half the tooth sticks out above the gum line.

The life of a river hippopotamus. River hippopotamuses are good swimmers and live in lakes, rivers, and streams near grasslands. They sometimes walk along the bottom of a body of water and can stay underwater for as long as six minutes. On land, they can run as fast as a human being—about 30 kilometres per hour.

River hippopotamuses live in herds of from 5 to 30 animals. They spend the day resting in the water, eating water plants, and sunning themselves on sandbanks. At night, the herd goes on land to feed. The animals eat fruit, grass, leaves, and vegetables. They sometimes wander for miles near the riverbank, grazing as they go. Each hippopotamus eats about 60 kilograms of vegetable matter a day.

A female hippopotamus carries her young inside her body for about 7½ months before it is born. She almost always has one baby at a time, but sometimes she bears twins. A baby hippopotamus, called a *calf,* weighs about 45 kilograms at birth. It can swim almost immediately and usually nurses on its mother's milk underwater. It begins to eat grass at the age of 4 to 6 months. A young hippopotamus often climbs on its mother's back and suns itself as she floats on the water. On land, the mother hippopotamus keeps her calf close by. If the youngster wanders away, she butts it as punishment.

A female hippopotamus gives birth to her first baby when she is 5 or 6 years old. Hippopotamuses live for about 30 years in their natural surrounding or 50 years in a zoo.

A hippopotamus has an enormous mouth and can open it to a width of 90 to 120 centimetres. The animal often does so to show its powerful canines and challenge its enemies. When two hippopotamuses fight, they slash at each other with their canines. Many fights continue until one of the animals gets killed or suffers a broken leg. Almost no other kind of animal attacks adult hippopotamuses, but crocodiles, hyenas, and lions sometimes attack the young. If a hippopotamus feels threatened on land, it runs for the water.

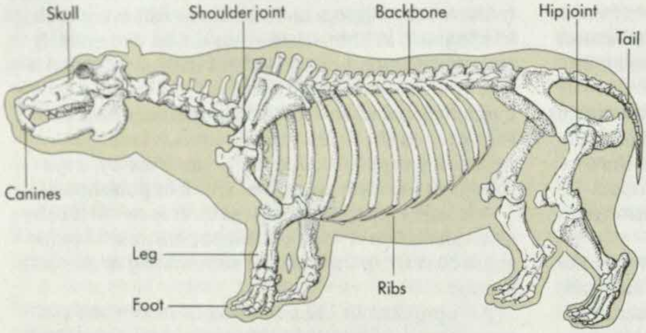
The pygmy hippopotamus has a smaller head in proportion to its body than does the river hippopotamus. It weighs from 180 to 270 kilograms and stands about 75 centimetres tall. A pygmy hippopotamus ranges from 1.5 to 1.8 metres long, not including the tail, which measures 15 to 18 centimetres long. The animal has blackish skin.

Pygmy hippopotamuses live in thick forests near streams and spend less time in the water than do river hippopotamuses. They live alone or in pairs, rather than in herds. Although the law forbids killing pygmy hippopotamuses, Africans shoot many of them for food. As a result, the animal faces the danger of becoming extinct.

Hippopotamuses and people. People have greatly reduced both the number of hippopotamuses and the size of the area in which they live. Hunters have killed large numbers of them, and farmers have made crop-

A river hippopotamus has a stout, barrel-shaped body; short legs; and a huge head. It weighs as much as 2,630 kilograms and ranks as one of the largest land animals. In spite of its clumsy appearance, the river hippopotamus is an excellent swimmer and can run as fast as a human being.

The skeleton of a river hippopotamus



A hippopotamus' tusklike canines can be seen when the animal opens its mouth. Hippopotamuses use their canines for fighting.

land out of many areas where hippopotamuses once made their home. At one time, the animals lived in rivers throughout Africa. Ancient Egyptian paintings show pharaohs hunting them on the Nile River.

African farmers shoot many hippopotamuses to keep the animals from eating or trampling their crops. They also kill hippopotamuses for the meat and use the hides in making soup. The canines of hippopotamuses provide valuable ivory. The ivory was once used for artificial teeth because it did not turn yellow.

Some food experts have urged that hippopotamuses be raised for their meat. The weight of the edible meat of a hippopotamus totals almost two-thirds the weight of the entire body. This proportion is much higher than with most other wild animals. In addition, hippopotamus flesh has an extremely high protein content.

Hippopotamuses have also benefited their environment in certain areas. Their solid wastes provide nourishment for many fish and water plants in the lakes and streams where hippopotamuses live.

Scientific classification. Hippopotamuses make up the hippopotamus family, Hippopotamidae. The river hippopotamus is *Hippopotamus amphibius.* The pygmy hippopotamus is *Choeropsis liberiensis.*

See also **Animal** (picture: Animals of the grasslands).

Hiram. See **Phoenicia** (The spread of Phoenician influence).

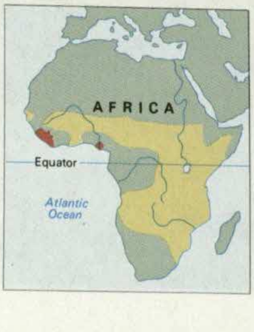
Hire purchase is a method of buying on credit. A store which sells goods on hire purchase usually requires that the buyer pay part of the price of an article at the time of the sale. The buyer then must pay equal parts of the remainder at stated times thereafter, until the bill is paid in full. These payments are called *deferred payments,* and may be extended over varying periods of time.

Buying goods on hire purchase is different from buying by most other methods of credit because the buyer does not become the owner until the last instalment has been paid. For example, when buying a £500 television set on hire purchase, the person may pay a £100 deposit and agree to pay the remaining £400 over a two-year period. If there is a charge of 10 per cent a year for borrowing the £400, another £80 is added to the cost. The £480 must then be paid back in 24 equal instalments of £20 a month. If the buyer fails to pay the instalments, the television will be returned to the trader. If the instalments are paid as agreed, it is not until after the final payment that the buyer becomes the legal owner of the television.

Hire purchase is not suitable for all goods. They must have a longer life than the period of credit being extended. Food and flowers would not be suitable. Clothes that are tailor-made to fit a particular person are also unsuitable. If the trader had to repossess such goods, no one else would want them. Goods that are suitable for hire purchase agreements include refrigerators, televisions, videos, furniture, and cars. Companies also often enter into hire purchase agreements to buy office machinery.

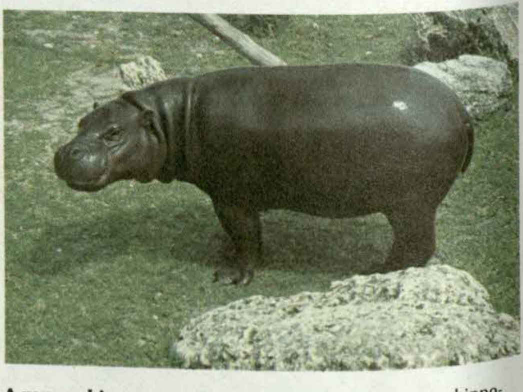
Where hippos live

The hippopotamus is found in central and southern Africa in rivers, lakes, and marshy ponds. The pygmy hippopotamus lives in Liberia, Sierra Leone, and south Nigeria.



🟨 Hippopotamus

🟥 Pygmy hippopotamus



A pygmy hippopotamus is much smaller than a river hippopotamus. The animal weighs from 180 to 270 kilograms. It has a rounded head and oily, blackish skin.

There are several advantages of buying goods under a hire purchase agreement. The buyer does not need to wait to save up the full price of the goods. Someone may need a car or van to carry out their work. Also, goods purchased under a hire purchase agreement may be covered by a guarantee, which means that if something goes wrong the buyer can withhold payment until it is put right. The disadvantages are that interest rates are normally very high, making the total cost of the goods far more than the cash price. The need to buy the goods on hire purchase may also limit the choice of goods available, since not all traders provide that kind of credit.

The advantage for traders is that they can sell more goods than if they only offered cash sales. They can charge more for the goods and make more profit. But there are also disadvantages. If the goods are not paid for, and the trader has to repossess them, they may come back damaged so that they cannot be sold to anyone else. The trader also needs more money available to buy more stock, since the initial payment will be low. Because of these problems, *finance companies* have been formed. They give the cash price to the trader less a charge for providing the service. Large trading companies and retail groups often form their own finance companies.

In many countries, hire purchase is declining in importance. Credit cards give a buyer immediate ownership of the goods, with greater flexibility in the method of payment.

Hirohito (1901-1989) was emperor of Japan from 1926 until his death in 1989. He chose *Showa* as his reign name, and was known as the Showa Emperor.

Before World War II. Hirohito became regent for his father, Yoshihito, in 1921 and he became emperor in December 1926. His reign began during the days of rising democratic sentiment. Universal manhood suffrage had just been introduced, and Japan seemed likely to become increasingly democratic and internationalist. Unfortunately, army circles, particularly those in Manchuria, wanted a stronger foreign policy. Within Japan, criticism of the political parties sharpened after economic crises struck. Military incidents abroad and assassinations in Tokyo soon reversed the democratic and internationalist trends of the 1920's.

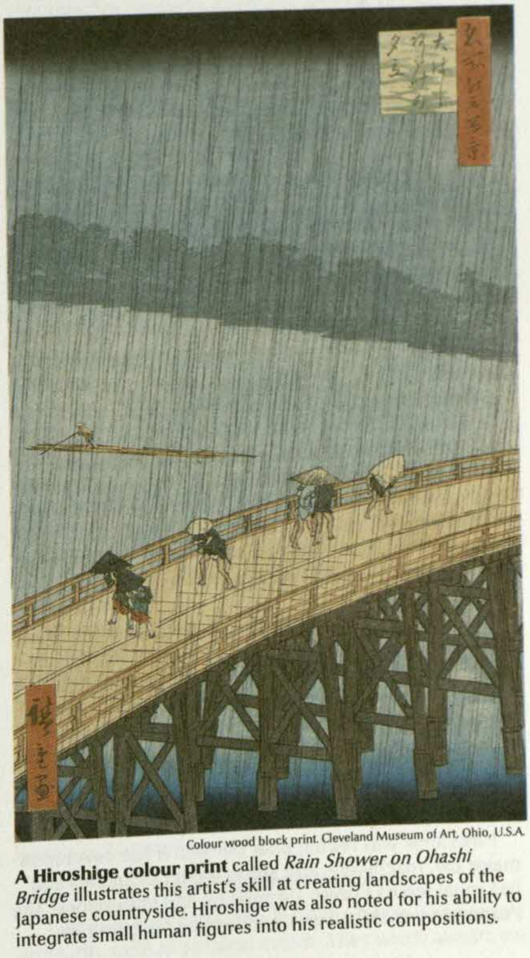
Hirohito personally opposed the militarism of the 1930's. But his advisers kept him from making his wishes known, so that the radical militarists would not take direct action against the monarchy. As a result, Hirohito remained silent, and approved the decisions which led to World War II (see **Japan** [World War II]).

Hirohito

After the war. Hirohito took a personal part in the final surrender decision of 1945. His broadcasts to the Japanese people helped bring about the smooth transfer of control of Japan to the United States Army. For a time, it was thought he might have to abdicate or be tried as a war criminal. Although several of the emperor's advisers were tried and convicted of war crimes, Hirohito himself was not.

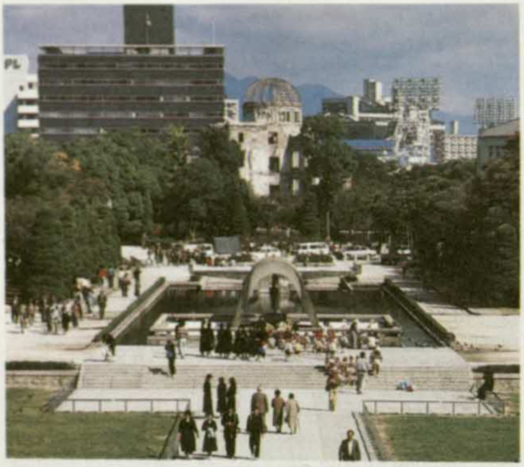
Hirohito did, however, take a new role. On Jan. 1, 1946, he renounced all claims to the divinity that had formerly been claimed for him. The constitution of 1947, which he approved, changed him from sovereign to "symbol of the state," and placed political control in the hands of elected representatives. As a democratic monarch, Hirohito toured the country, visiting scenes of disaster and inspecting Japan's postwar reconstruction. He permitted the imperial family to be photographed, a practice never allowed before. Hirohito chose an American tutor to teach his son, Crown Prince Akihito. In 1959, Akihito broke a centuries-old Japanese tradition by marrying a "commoner," a young woman who did not belong to one of Japan's noble families (see **Akihito**). In 1971, Hirohito became the first Japanese emperor to travel outside Japan during his reign. He toured Europe for 18 days. He visited the United States in 1975. In private life, Hirohito carried on research in marine biology.

Hiroshige (1797-1858), was a master painter and designer of Japanese colour prints. Many critics rank him



Colour wood block print. Cleveland Museum of Art, Ohio, U.S.A.

A Hiroshige colour print called *Rain Shower on Ohashi Bridge* illustrates this artist's skill at creating landscapes of the Japanese countryside. Hiroshige was also noted for his ability to integrate small human figures into his realistic compositions.



Hiroshima's Peace Park is a memorial to the victims of the first atomic bomb used in war. The domed ruin, the Prefectural Industrial Promotion Hall, *centre,* marks the centre of the blast.

second in importance only to Hokusai among Japanese artists of the 1800's. His paintings earned him the name of "the artist of the sweeping brush," because of his ability to suggest vast landscapes in a few lines. Bare paper is as important as colour in showing great snowfields, the sea, and the sky in his paintings. His delicate colour harmonies and his peculiar perspective influenced the work of the painter James Whistler.

Hiroshige was born in Edo (now Tokyo). His pupils imitated his work and often used his signature. His most famous set of prints is the *Fifty-three Stations of the Tokaido Highway.*

See also **Japanese print** (picture).

Hiroshima (pop. 1,044,129) is the Japanese city on which the first atomic bomb used in warfare was dropped. It lies on islands formed by a river delta on the north shore of the Inland Sea, in western Honshu. For location, see **Japan** (political map).

Hiroshima was originally a fishing village, but developed dramatically between 1600 and 1868 as a castle town of the Asano family. By the late 1600's, it had become one of Japan's largest cities. It served as a seat of local government, and as a trade centre and a port of internal navigation. Its prosperity and population increased in the late 1800's and early 1900's with its industrial growth. By World War II, Hiroshima was an important military centre.

During World War II, on Aug. 6, 1945, a United States Army plane dropped a single atomic bomb on the centre of the city. Three days later, the Americans dropped a second atomic bomb on the city of Nagasaki. Japan surrendered to the Allied forces on Sept. 2, 1945.

The atomic bomb destroyed about 13 square kilometres of the city. Between 70,000 and 100,000 people are estimated to have been killed. More people died later from the effects of atomic radiation.

Hiroshima was rebuilt after the war. It has developed major car, machinery, and shipbuilding industries and has regained its prewar population and importance. The Peace Memorial Park was built where the bomb exploded. A service is held there each year on the anniversary of the bombing, in memory of the victims. The Atomic Bomb Dome, a building left unreconstructed after the war, has become a symbol of the peace movement.

See also **Nuclear weapon** (picture).

Hirshhorn Museum and Sculpture Garden, in Washington, D.C., U.S.A., houses one of the world's largest collections of modern art. The Hirshhorn has more than 6,500 paintings and sculptures by leading American and European artists of the late 1800's and the 1900's. It is part of the Smithsonian Institution.

The Hirshhorn Museum is an unusual circular building. Most of the museum's paintings are by American masters, such as Willem de Kooning, Thomas Eakins, and Edward Hopper. The sculpture collection includes works by Alexander Calder, Edgar Degas, Alberto Giacometti, Henry Moore, Louise Nevelson, and Pablo Picasso. The sculpture garden and plaza alongside the museum feature massive works by some of these sculptors and others, including Auguste Rodin and Henri Matisse. The Hirshhorn's Moore sculptures make up the largest public collection in the United States of Moore's work.

Hispaniola is the second largest island in the West Indies. It lies between Cuba and Puerto Rico in the Caribbean Sea, about 970 kilometres southeast of Florida, U.S.A. For the location of Hispaniola, see **West Indies** (map). The Republic of Haiti occupies the western third of Hispaniola, and the Dominican Republic covers the eastern two-thirds of the island. The island is about 640 kilometres long and 240 kilometres wide. Hispaniola has an area of about 76,456 square kilometres. Christopher Columbus arrived at Hispaniola in 1492 and called it *La Isla Española* (the Spanish Island).

Hispaniola has a population of about 13 million. Nearly all the people are blacks or have mixed black and white ancestry. More than half the people live in rural areas and make their living from agriculture. The chief crops are coffee and sugar cane.

See also **Dominican Republic; Haiti.**

Hiss, Alger (1904-   ), became the centre of a national controversy over Communist infiltration in the U.S. government during the administration of President Harry S. Truman in the 1940's and 1950's. A number of Republican congressmen, including Representative Richard Nixon, had charged the government with unwittingly employing secret Communists who acted as agents for the Soviet Union.

The controversy reached a climax in 1948. At that time, Whittaker Chambers, a confessed former Communist spy, accused Hiss, a former high official in the U.S. Department of State, of having given him military secrets in the 1930's. Hiss denied the charge, but resigned from his position as head of the Carnegie Endowment for International Peace. Chambers then produced microfilms of confidential government papers that he had hidden in a pumpkin on his farm in Maryland. Chambers said Hiss had given him the secrets to send to the Soviet Union.

Hiss was brought to trial in 1949. He was charged with perjury for denying Chambers' accusations. Important government officials, including two associate justices of the Supreme Court of the United States, testified for

Hiss and his accuser, Whittaker Chambers, were brought face to face during a session of the House Un-American Activities Committee in 1948. Hiss, *standing, left,* was convicted of perjury largely on evidence supplied to the government by Chambers, *standing, far right.*

Hiss. But the jury could not agree on a verdict.

Again, Hiss was brought to trial on the same perjury charges late in 1949. The government introduced new evidence in an attempt to prove that the personal typewriter of Hiss had been used to copy 42 confidential government documents. On Jan. 21, 1950, the jury found him guilty. Hiss was sentenced to five years in prison. He was paroled after serving 3 years and 8 months, and he continued to declare his innocence.

Hiss was born in Baltimore and graduated with honours from Johns Hopkins University and the Harvard Law School. He served in the Department of State from 1935 to 1947. He was executive secretary of the Dumbarton Oaks Conference, a technical adviser at the Yalta Conference, and secretary-general of the United Nations founding convention.

See also **McCarthy, Joseph R.; Nixon, Richard M.; Yalta Conference.**

Histamine. See **Allergy** (How an allergy develops); **Antihistamine.**

Histology is the biological science that studies the structure of the tissues of organisms. In the early 1600's, scientists began using simple microscopes to observe the structural features of various plants and animals. Histology developed as a science in the mid-1800's, when the use of compound microscopes made it possible to view features of cellular and subcellular tissues. Today, the electron microscope enables histologists to examine details of tissues magnified hundreds of thousands of times. By using various chemical techniques, histologists can identify the precise location of various proteins, lipids, and carbohydrates in tissues.

Related articles in *World Book* include:

Bichat, Marie F. X.
Botany
Cell
Malpighi, Marcello
Microscope
Tissue

Histoplasmosis is a fungal infection that attacks the lungs, mouth, throat, ears, spleen, liver, and lymphatic system. When confined to the lungs, the disease is usually mild. But it can be fatal if it spreads to other parts of the body.

Histoplasmosis occurs throughout the world. But it is most common in the Ohio and Mississippi river valleys of the United States. The fungus, *Histoplasma capsulatum,* grows in moist soil. Its *spores* (cells) are released into the air and inhaled into the lungs.

Historian. See **History** with its *Related articles.*

Historic age. See **Age.**

Historiography. See **History** (Interpreting historical events).

History. For information on the history of individual countries, see articles listed under the name of the country. For example, **Australia, History of.**

History is the study of the human past. Historians study records of past events and prepare new records based on their research. These records, as well as the events themselves, are also commonly called history. This article discusses history as a field of study. For information on events in history, see **World, History of the,** and the *History* sections of the various articles on continents, countries, states, and provinces.

The past has left many traces, including traditions, folk tales, works of art, archaeological objects, and books and other written records. Historians use all these resources, but they mainly study the past as it has been recorded in written documents. As a result, history is generally limited to human events that have taken place since the development of writing about 5,500 years ago.

Historians study all aspects of past human life—social and cultural conditions as well as political and economic events. Some historians study the past simply to understand better how people of other times acted and thought. Others seek to draw lessons from those actions and thoughts as a guide for decisions and policies today. However, historians disagree about the lessons of history, and so there are many different interpretations of the past.

History became a field of study in many schools during the 1800's. Today, students throughout the world study history in school. They learn about the past chiefly from textbooks, but also through such activities as field trips to historical sites and visits to museums. Most nations require schools to teach their country's heritage as a means of developing patriotism. History is thus used not only to tell students how their national way of life developed, but also to justify and support national ideals and institutions.

What historians study

The content of history. Until the 1900's, historians primarily studied political events. They wrote almost ex-

A visit to a historical site helps people learn about the past and gain an understanding of life in earlier societies. Colonial Williamsburg, *left*, is a section of Williamsburg, Virginia, U.S.A., where buildings have been restored to appear as they did during the 1700's.

clusively about diplomacy, wars, and affairs of state. Today, historians also study many other subjects. Some examine economic and social conditions. Others trace the development of religions, the arts, or other elements of culture.

History is often classified as one of the social sciences, along with such fields as economics, psychology, and sociology. However, historians differ from other social scientists in the way in which they study social processes. Other social scientists seek to develop general laws by examining patterns of behaviour that recur throughout time. In contrast, historians study the conditions or events of a particular time. Historians may use theories from the other social sciences to help explain these conditions and events. But historians rarely attempt to develop general laws.

The divisions of history. The field of history is so vast that historians have traditionally split it into divisions. The three main divisions of history are based on *period, nation,* and *topic.*

Periods of time form the chief divisions in the study of history. Historians divide Western history into three periods: (1) ancient times, from about 3000 B.C. to the A.D. 400's; (2) medieval times, the 400's to the 1500's; and (3) modern times, the 1500's to the present. Scholars, in turn, may divide these periods into many shorter periods. For example, a historian may study a particular century or a certain period, such as the High Middle Ages (about the 1200's) or the Age of Reason (1700's).

The division of history into periods helps historians organize and focus their studies. However, this division may distort the evidence presented by history. For years, historians considered the medieval era as a period of superstition and disorganization that came between two supposedly better periods of history. This viewpoint prevented them from realizing that the Middle Ages had a vitality of its own and formed the basis of modern European civilization.

The division of history into ancient, medieval, and modern periods applies only to European societies. Historians who study Asian or African societies base their work on entirely different periods. Even the dating system differs because Western society uses the birth of Jesus Christ as a dividing line. The years before the birth of Christ are designated B.C. (before Christ), and those thereafter are considered A.D. (*anno Domini*—in the year of our Lord).

The division of history by nation involves, for example, the study of American, Chinese, or French history. The division by topic enables historians to deal with particular aspects of past human activity. Many historians study economic, social, and intellectual history in addition to studying traditional political history. Some historians focus on such specialized topics as the history of science, of an ethnic group, or of a city.

How historians work

The study of history involves many processes and techniques, but most historians follow a few basic steps in their work. First, they select for study an issue or person from some period of the past. Next, they try to read a variety of source materials—everything written by or about the subject. Then they interpret the information obtained from these sources. Finally, they write a narrative history or a biography.

Choosing and evaluating sources. Historians use two main types of sources in their research, *primary sources* and *secondary sources.* Primary sources consist of documents and other records produced during the period being studied. They include books, diaries, letters, and government records. Films and tape recordings may serve as primary sources for events of the 1900's. Secondary sources are materials prepared later by people who studied the primary sources.

Historians choose documents that reveal most accurately the facts they wish to know. Therefore, they prefer primary sources to secondary ones, and confidential reports to public ones. Historians who study recent events use a special type of source. They go to participants in those events and record their oral testimony. Such *oral history* supplements documentary history.

The scarcity of sources is a great problem for historians, whose work sometimes resembles that of detectives. Many activities and thoughts of ordinary people, plus other useful data, were never recorded. Much that was written down has been lost or destroyed through the years. Also, historians often must rely on the writings of only a few people. Such writings are mere fragments on which to base a reconstruction of the past.

Historians analyse the documents with which they work to determine the reliability of these sources. They compare documents with other sources and also check for such flaws as errors in the order of events or variations in writing style. In addition, the historian must determine whether the author's account of events can be trusted.

Interpreting historical events. Basic historical facts are data generally accepted by all historians because the evidence for them seems unquestionable. However, historians often disagree about the meaning and significance of such facts. These experts try to be as unbiased as possible, but their own beliefs and prejudices influence their interpretation. For example, a historian's social, economic, and religious views help determine what he or she accepts as "normal" in another person. This judgment, in turn, determines what the historian accepts as reliable testimony or as a likely sequence of events. Such interpretation explains why historians who use the same data may disagree about events and their significance.

Some historians rely heavily on information from other social sciences to form their interpretations. For example, the study of history that uses theories and insights from psychology is called *psychohistory.* Similarly, some historians use statistical methods to interpret data from such sources as old censuses and account books. This approach is called *cliometrics.*

As the last step in interpretation, a historian prepares a written account of events. The writing of history is part of a field called *historiography.* Some of the best historians use the techniques of the novelist and dramatist to entertain as well as inform.

Theories of history

Since ancient times, scholars have developed theories of history that attempt to explain the entire course of human events through some general principle. For example, the ancient Greeks regarded history as a cycle of events that repeated itself endlessly. In contrast, the traditional Christian theory considers history as a series of events with a beginning and an end. According to this theory, God directs human events toward the final goal of the redemption of humanity. This theory dominated nearly all the history written in Europe during the Middle Ages.

In modern times, scholars have proposed many other theories. During the late 1700's and the 1800's, philosophers developed the concept of history as a process of inevitable progress. They believed this progress would eventually lead to a thoroughly logical social order based on a scientific understanding of human events.

The German historian Oswald Spengler argued in his book *The Decline of the West* (1918-1922) that civilizations, like organisms, go through a cycle of birth, development, and death. Arnold Toynbee, a British historian, also presented a cyclical theory in his 12-volume work, *A Study of History* (1934-1961). However, Toynbee disagreed with Spengler's belief that modern Western civilization is already doomed.

Nearly all theories of history assume that it has meaning and purpose, but there is no overwhelming evidence to support this concept. In fact, many scholars today question whether history has any meaning other than that which people read into it. As a result, most modern philosophers have turned away from such theories. Instead, they examine such issues as the nature of history as a field of knowledge and the method of explanation used by historians.

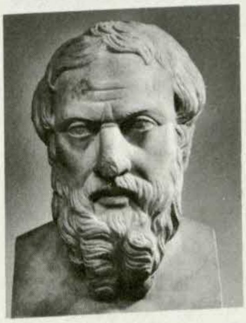
The development of historical writing

Ancient times. The world's oldest written history comes from China. Archaeologists have discovered records of Chinese history written before 1000 B.C. The first great Chinese historian, Sima Qian (also spelled Sou-ma Ch'ien), wrote the earliest major history of China about 100 B.C.

Western historical writing began in ancient Greece. The first major Greek historian was Herodotus, who lived during the 400's B.C. He wrote a long account of the wars between the Greeks and the Persians. Herodotus, who is often called the "Father of History," had few Greek documents and could not read Persian. Therefore, he based his narrative primarily on tradition and oral testimony. He added fictitious details to make it more lively, but modern historians have confirmed the basic accuracy of his writing. Herodotus' most famous successor, Thucydides, strove to write critically and accurately. His *History of the Peloponnesian War* is an authentic account of the 27-year war in which Sparta finally defeated Athens in 404 B.C.

Several ancient Romans also became famous historians. Livy (Titus Livius) wrote a long, detailed narrative called *History from the Founding of the City.* It tells the story of Rome from the city's birth until 9 B.C. Cornelius Tacitus is known especially for his *Histories* and *Annals.* These works examine Roman history from the death of the emperor Augustus in A.D. 14 up to the reign of Vitellius, which ended in A.D. 69.

Medieval times. Christian writers, including a number of monks, contributed almost all the historical accounts of medieval times that were written during that period. Some Christian historians attempted to write a *universal history* by combining Jewish and Christian history with the record of the Greek and Roman past. During the early 300's, Eusebius, the bishop of Caesarea in



Marble statue (A.D. 100's) by unknown Roman sculptor; Metropolitan Museum of Art, New York City

Herodotus, an ancient Greek historian, is often called the "Father of History."

Detail of an oil portrait (1868) by Julius F. A. Schrader; National-galerie, Berlin

Leopold von Ranke of Germany developed many basic historical research methods.

Palestine, produced the most important universal history of that type. In another work, *Ecclesiastical History,* Eusebius presented a history of Christianity to show that God controlled human events. During the 400's, Saint Augustine developed this idea fully into a philosophy of history in his book *The City of God.*

The greatest historian of the early Middle Ages was an English monk named Bede. His major work, *Ecclesiastical History of the English Nation* (731), is still the principal source for English history up to that time. Bede and the other medieval historians tried to show the hand of God in historical events. Today, their works are significant chiefly as records of the events of their times.

During the 1300's, a great Arab historian named Ibn Khaldun wrote his seven-volume *Universal History,* a study of world civilization. Also at this time in Europe, people other than members of the clergy started to write histories. European historians of the 1400's began to concentrate more on the human view of events and less on the divine aspect.

Modern times. An important early modern historian was the British scholar Edward Gibbon. His masterpiece, *History of the Decline and Fall of the Roman Empire* (1776-1788), reveals Gibbon's accurate and thorough scholarship. This work also reflects the anti-Christian bias of Gibbon and other great thinkers of his day. Gibbon's book blames Christianity in part for the fall of the Roman Empire.

The methods of modern historical study were developed during the 1800's, and history became a recognized academic field. Leopold von Ranke, a German historian, had the most significant impact on the development of history in the 1800's. Ranke, who is known as the "Father of Modern History," devised the basic methods used by modern historians to analyse and evaluate documents. He also introduced the use of seminars for training future historians in methods of research.

Ranke mainly studied political history. During the 1900's, however, European and American historians began to emphasize the importance of social and economic forces in history. Today, historians study these and all other aspects of the human past.

Related articles in ***World Book.*** See **World, History of the,** and the *History* section of the various articles on continents, countries, states, and provinces. See also the following articles:

American historians

Bancroft, George
Barzun, Jacques
Beard, Charles and Mary
Catton, Bruce
De Voto, Bernard
Du Bois, W. E. B.
Morison, Samuel Eliot
Nevins, Allan
Parkman, Francis
Quarles, Benjamin A.
Tuchman, Barbara W.

British historians

Acton, Lord
Bede
Carlyle, Thomas
Churchill, Sir Winston
Clarendon, Earl of
Geoffrey of Monmouth
Gibbon, Edward
Macaulay, Thomas B.
Maitland, Frederic W.
Trevelyan, George M.

French historians

Froissart, Jean
Montesquieu
Taine, Hippolyte A.
Thiers, Louis A.
Voltaire

German historians

Herder, Johann G. von
Ranke, Leopold von
Spengler, Oswald

Other historians

Caesar, Julius
Herodotus
Huizinga, Johan
Ibn Khaldun
Josephus, Flavius
Livy
Pirenne, Henri
Plutarch
Suetonius
Tacitus, Cornelius
Thucydides
Xenophon

Other related articles

See the following with their *Related articles:*

Ancient civilization
Archaeology
Byzantine Empire
Culture
Egypt, Ancient
Exploration
Greece, Ancient
Indian, American
Industrial Revolution
Middle Ages
Mongol Empire
Persia, Ancient
Prehistoric people
Reformation
Renaissance
Rome, Ancient
United Nations
United States, History of the
War

Hitchcock, Sir Alfred (1899-1980), was an English film director and producer. He won fame for his thrillers, first in England, and later in the United States.

Sir Alfred Hitchcock

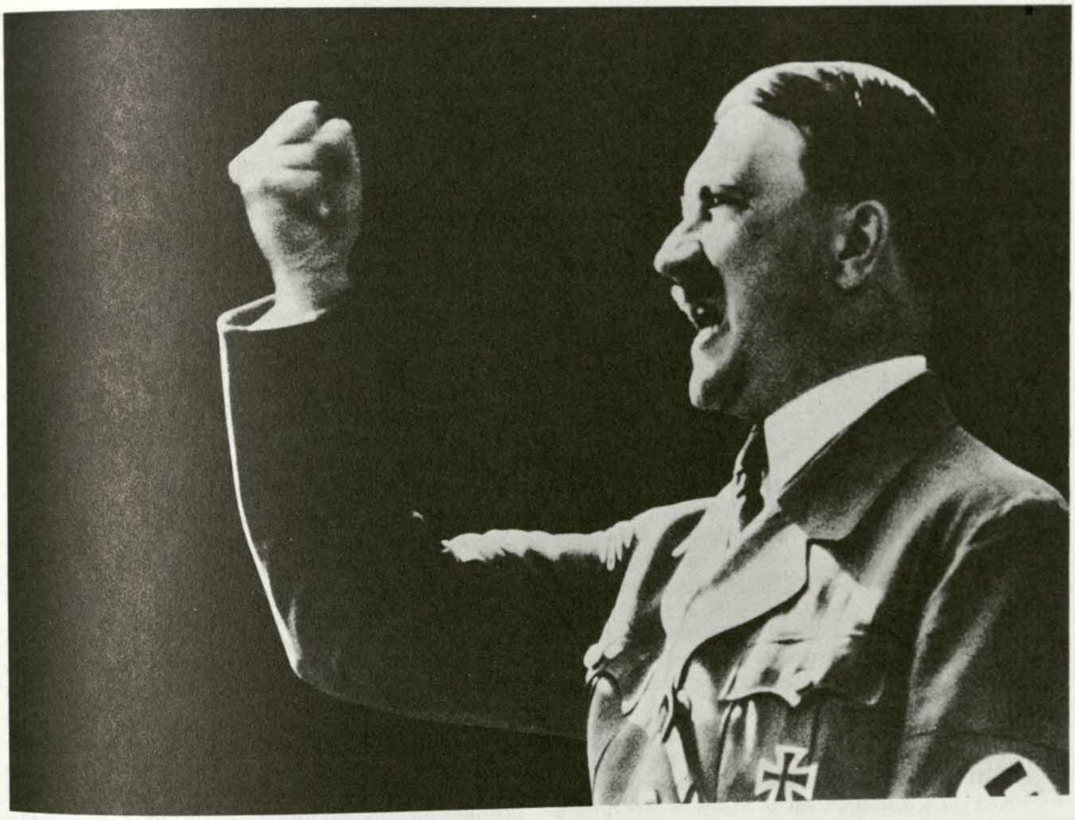
Hitchcock's English films, made during the 1920's and 1930's, were fast-paced, straightforward melodramas. They featured exciting chases, rather than plot and character development. *The Pleasure Garden* (1925) was Hitchcock's first film. He gained his first successes with *The Lodger* (1926), based on the Jack the Ripper murders; and *Blackmail* (1929), one of the first British sound films. Hitchcock came to the attention of Hollywood after making the skilful suspense films *The Man Who Knew Too Much* (1934, remade in 1956), *The 39 Steps* (1935), and *The Lady Vanishes* (1938).

Hitchcock moved to the United States in 1939, and became a United States citizen in 1955. In contrast to his English movies, Hitchcock's American films probed more deeply into the psychology of the characters and were longer, more complex works. *Rebecca* (1940), Hitchcock's first United States film, received the Academy Award as best picture. His other major American films include *Shadow of a Doubt* (1942), *Spellbound* (1945), *Strangers on a Train* (1951), *North by Northwest* (1959), *Psycho* (1960), and *Frenzy* (1972). Although Hitchcock never won an Academy Award as best director, he did receive the Academy's life achievement award in 1967.

From 1955 to 1962, Hitchcock produced and hosted the 30-minute television series "Alfred Hitchcock Presents." He continued to produce and host the series from 1962 to 1965 when it became "The Alfred Hitchcock Hour." Hitchcock was knighted in 1980. Alfred Joseph Hitchcock was born in London.

Hitchcock, Tommy, Jr. See Polo (History).

Hitches. See Knots, hitches, and splices.



Adolf Hitler was dictator of Germany from 1933 to 1945.

Adolf Hitler

Hitler's signature

Hitler, Adolf (1889-1945), ruled Germany as dictator from 1933 to 1945. He turned Germany into a powerful war machine and provoked World War II in 1939. Hitler's forces conquered most of Europe before they were defeated in 1945.

Hitler spread death as no person has done in modern history. "Have no pity! Act brutally!" he told his soldiers. He ordered tens of thousands of those who opposed him to be executed, and hundreds of thousands to be thrown into prison. He was totally unscrupulous and believed that the strong must win, while the weak lose. In the struggle for power, any trick, however ruthless, was justified. His strength of will, his ability to lie, cheat, and flatter helped him to win power.

Hitler particularly persecuted Jews. He ordered them removed and killed in countries he controlled. Hitler set up concentration camps where about 3 million Jews were murdered. Altogether, Hitler's forces killed about 6 million European Jews as well as about 5 million other people that Hitler regarded as racially inferior or politically dangerous.

Adolf Hitler began his rise to political power in 1919, the year after World War I had ended. The German Empire had been defeated, and the nation's economy lay in ruins. Hitler joined a small group of men who became known as *Nazis.* He soon became their leader. Hitler and his followers believed he could win back Germany's past glory. He promised to rebuild Germany into a mighty empire that would last a thousand years.

Many people did not take Hitler seriously. But his fiery words and brilliant blue eyes seemed to hypnotize those who listened to him. Many Germans believed he was their protector and friend. His emotional speeches made crowds cheer "Heil, Hitler!" ("Hail, Hitler!").

Hitler became dictator of Germany in 1933 and quickly succeeded in regaining some territories taken from Germany as a result of World War I. He threatened war against Czechoslovakia in 1938, but was stopped by a combination of counterthreats and concessions. His forces invaded Poland in 1939. Then Great Britain, France, Australia, New Zealand, South Africa, and Canada declared war on Germany, and World War II began.

Hitler had a clear vision of what he wanted, and he had the daring to pursue it. But his aims had no limits, and he overestimated the resources and abilities of Germany. Hitler had little regard for experts in any field. He regularly ignored the advice of his generals and followed his own judgment, even while Germany was being defeated in the last years of the war. Finally, as the United States, British, and Soviet troops closed in on the heart of Germany, during the first months of 1945, Hitler killed himself.

For a detailed discussion of conditions in Germany during Hitler's time, see **Germany** (History).

Early life

Boyhood. Adolf Hitler was born on April 20, 1889, in Braunau, Austria, a small town across the Inn River from Germany. He was the fourth child of the third marriage of Alois Hitler, a customs official. Alois Hitler was 51 years old when Adolf was born. Adolf's mother, Klara Pölzl, was 28 years old. She was a farmer's daughter.

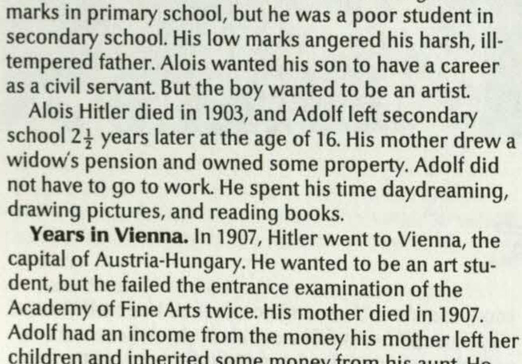
Alois Hitler was born to an unmarried woman named Anna Maria Schicklgruber. A wandering miller named Johann Georg Hiedler married her about five years later. Hiedler died in 1856, when Alois was 20 years old, having never recognized Alois as his child. In 1876, Hiedler's brother arranged for Alois to be registered as the legitimate son of Johann Georg and Maria Hiedler. The priest who made the entry spelled the name "Hitler." Years later, before he came to power, some of Hitler's political opponents called him Schicklgruber as an insult. Only four of Alois Hitler's eight children lived to adulthood. Adolf had a sister, Paula; a half brother, Alois; and a half sister, Angela.

About six years after Adolf's birth, his father retired and moved near Linz, Austria. Adolf received good marks in primary school, but he was a poor student in secondary school. His low marks angered his harsh, ill-tempered father. Alois wanted his son to have a career as a civil servant. But the boy wanted to be an artist.

Alois Hitler died in 1903, and Adolf left secondary school 2½ years later at the age of 16. His mother drew a widow's pension and owned some property. Adolf did not have to go to work. He spent his time daydreaming, drawing pictures, and reading books.

Years in Vienna. In 1907, Hitler went to Vienna, the capital of Austria-Hungary. He wanted to be an art student, but he failed the entrance examination of the Academy of Fine Arts twice. His mother died in 1907. Adolf had an income from the money his mother left her children and inherited some money from his aunt. He also claimed an orphan's pension. Sometimes he sold his drawings and paintings. He lived comfortably and idly during most of his stay in Vienna, considering himself an artist.

Hitler also concerned himself with political observations, admiring the effective leadership and organization of the Social Democratic Party in Vienna. He developed a growing hatred for Jews and Slavs. Like many German-speaking Austrians, Hitler became fiercely nationalistic. No form of government could last, he thought, if it treated people of different nationalities equally.



Hitler's birthplace was in Braunau, Austria, near the German border. As a boy, Hitler wanted to be an artist.

Corporal Hitler. In 1913, Hitler moved to Munich, Germany. The Austrian Army called him for a physical examination, but he was found unfit for service.

World War I began in August 1914. Hitler volunteered immediately for service in the German Army and was accepted. He served valiantly as a messenger on the Western Front for most of the war, taking part in some of the bloodiest battles. He was wounded and twice decorated for bravery. But Hitler rose only to the rank of corporal. When Germany surrendered in November 1918, he was in a military hospital recovering from temporary blindness that resulted from his exposure in battle to mustard gas. He was deeply shaken by news of the armistice. He believed that the unity of the German nation was threatened, and that he must attempt to save Germany.

Rise to power

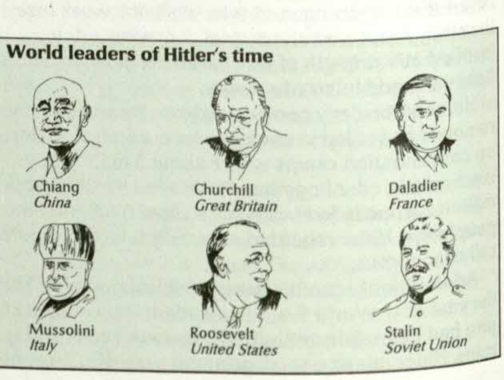
Defeat in World War I shocked the German people. Despair and turmoil increased as the army returned to a bankrupt country. Millions of Germans could not find work. A socialist-liberal republic replaced the defeated empire (see **Germany** [The Weimar Republic]).

After World War I, Germany was forced to sign the Treaty of Versailles. The treaty held Germany responsible for the war. It stripped the nation of much territory and restricted the German Army to 100,000 men. It also provided for a 15-year foreign occupation of an area of western Germany called the Rhineland. But the harshest part was the demand that Germany pay huge *reparations* (payments for war damages). The sums demanded

Important dates in Hitler's life

1889	(April 20) Born in Braunau, Austria.
1914-1918	Fought in the German Army in World War I.
1923	Led the Beer Hall Putsch.
1924	Began to write *Mein Kampf* while imprisoned for treason.
1933	Named chancellor of Germany; began rearming Germany.
1936	Sent his troops into the Rhineland.
1939	Began World War II by invading Poland.
1945	Committed suicide in Berlin.

World leaders of Hitler's time



by the treaty were so great that they made peace difficult. Nationalists, Communists, and others attacked the new government. The nationalists demanded punishment for the "criminals" who had signed the treaty.

Birth of the Nazi Party. After Hitler recovered from the effects of the mustard gas, he returned to Munich and remained in the army until March 1920. In the autumn of 1919, he began to attend meetings of a small nationalist group called the German Workers' Party. He joined the party and changed its name to the National Socialist German Workers' Party. The group became known as the Nazi Party. The Nazis called for the union of all Germans into one nation, including the Austrians and German minorities in Czechoslovakia and other countries. They demanded that citizens of non-German or Jewish origin be deprived of German citizenship, and they called for the cancellation of the Treaty of Versailles.

Hitler was a skilful politician and organizer. He became leader of the Nazis and quickly built up party membership—partly by his ability to stir crowds with his speeches. Hitler attacked the government and declared that the Nazi Party could restore the economy, assure work for all, and lead Germany to greatness again.

Hitler also organized a private army he called *storm troopers.* He used brown-shirted uniforms and the swastika emblem to give his party and the storm troopers—known as the SA—a sense of unity and power (see **Swastika**). The troopers fought the armies of the Communist, Social Democratic, and other parties who opposed Nazi ideas or tried to break up Nazi Party rallies. By October 1923, the storm troopers numbered 15,000 members. They had a considerable number of machine guns and rifles.

The Beer Hall Putsch. In 1923, Germany was in deep trouble. France and Belgium had sent troops to occupy the Ruhr District, the chief industrial region. German workers there responded by going on strike. The strike aggravated a crisis in Germany's economy, which had already been weakened by the reparations payments, and German money lost almost all value. Communist and nationalist revolts flared up throughout Germany, and the state of Bavaria was in open conflict with the central government in Berlin. Hitler saw an opportunity amid these troubles to overthrow both the Bavarian and national German governments.

On Nov. 8, 1923, at a rally in a Munich beer hall, Hitler proclaimed a Nazi revolution, or *putsch.* The next day, he tried to seize the Bavarian government in what became known as the Beer Hall Putsch. Hitler, supported by the German General Erich F. W. Ludendorff, led over 2,000 storm troopers on a march against the Bavarian government. But state police opened fire and stopped the procession, killing 16 marchers. The plot failed. Hitler was arrested and sentenced to five years in prison.

Mein Kampf. While he was imprisoned, Hitler began writing his book *Mein Kampf (My Struggle).* In the book, he stated his beliefs and his ideas for Germany's future, including his plan to conquer much of Europe. Territories lost in World War I would be recovered. Austria and parts of Czechoslovakia where Germans lived would be added to Germany. The growing German nation would seize *lebensraum* (living space) from Poland, the Soviet Union, and other countries to the east.

Hitler also wrote that Germans represented a superior form of humanity. They must stay "pure," he said, by avoiding marriage to Jews and Slavs. Hitler blamed the Jews for the evils of the world. He accused them of corrupting everything of ethical and national value. He said: "By defending myself against the Jews, I am doing the Lord's work." Democracy, said Hitler, could lead only to Communism. A dictatorship was the only way to save Germany from the threats of Communism and Jewish treason.

Rise of the Nazis. Hitler was freed about nine months after his trial. He left prison in December 1924.

Great changes had taken place in Germany during 1924. A schedule for Germany's reparations payments helped stabilize the German currency, and the nation showed signs of recovering from the war. Most people had work, homes, food, and hope for the future.

The government had outlawed the Nazis after the Beer Hall Putsch. Many party members had drifted into other political groups. After Hitler was released from prison, he began to rebuild his party. He gradually convinced the government that the party would act legally, and the government lifted its ban on the Nazis. Hitler won friends in small towns, in trade unions, and among farmers and a few business people and industrialists. He also set up an elite party guard, the *Schutzstaffel,* known as the SS. By 1929, though the Nazis had not yet gained substantial voter support, their organization and discipline had made them an important minority party.

By this time, Hitler had assembled some of the people who would help him rise to power. They included Joseph Goebbels, the chief Nazi propagandist; Hermann Goering, who became second in command to Hitler; Rudolf Hess, Hitler's faithful private secretary; Heinrich Himmler, the leader of the SS; Ernst Röhm, the chief of the SA; and Alfred Rosenberg, the party philosopher.

In 1930, the worldwide Great Depression hit Germany. Workers again faced unemployment and hunger. That same year, Germany agreed to the Young Plan of 1929 to reschedule reparations payments. In 1929, Hitler had launched a campaign to defeat the plan. This campaign made him a political force throughout the country. He led protest marches, organized mass meetings, and delivered speeches all over Germany.

Hitler used his old arguments in the campaign against the Young Plan and in a national election campaign that took place in 1930. But he toned down his violent speeches against Jews, which had failed to attract many votes. Hitler promised to rid Germany of Communists and other "enemies" and to reunite Germany and all the other parts of Europe in which German was spoken.

In 1932, five major elections were held in Germany as its leaders struggled to give the nation political stability. In the July elections for the *Reichstag* (parliament), the Nazis became Germany's strongest party, receiving nearly 38 per cent of the vote. Leaders of the other parties offered Hitler Cabinet posts in exchange for Nazi support. But as leader of the strongest party, he refused to accept any arrangement that did not make him *chancellor* (prime minister) of Germany.

The majority of the German people and the leading politicians did not want Hitler to become chancellor. They understood that he would make himself dictator and set up a reign of terror. Germany's president, Paul von Hindenburg, also had serious misgivings about Hitler. But the 85-year-old Hindenburg, persuaded by his friends and his son Oskar, accepted Hitler's promise to act lawfully if he were named to form a government. On Jan. 30, 1933, Hindenburg named Hitler chancellor.

Dictator of Germany

There were only two Nazis in the Cabinet besides Hitler—Goering and Wilhelm Frick. The rest of the 11-member Cabinet was made up of politicians who were more moderate than the Nazis. The vice chancellor, Franz von Papen, and his political allies thought this arrangement would limit Hitler's power. But Hitler had never settled for anything less than full control. He moved steadily toward dictatorship. There was no place for freedom under his government, which Hitler called the *Third Reich* (see **Reich**).

The New Order. The Nazis, through Frick's key position as minister of the interior, controlled all national police authority. Goering controlled the Prussian police. An emergency decree signed by Hindenburg on Feb. 4, 1933, gave the Nazis legal authority to prohibit assemblies, to outlaw newspapers and other publications, and to arrest people on suspicion of treason. The Nazis were thus able to put down much of their political opposition. Goering created an auxiliary police force made up of thousands of storm troopers and ordered them to shoot in encounters with "enemies."

On Feb. 27, 1933, a fire began that destroyed the Reichstag building. Many historians believe that it was planned by the Nazis. A pro-Communist Dutch anarchist was found at the site of the fire and admitted that he had started it. The Nazis quickly blamed the Communists. Hindenburg signed another emergency decree that gave the government almost unlimited powers.

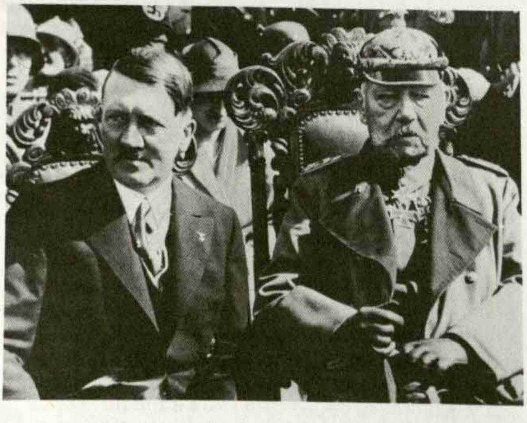
Elections for a new Reichstag were held on March 5, 1933. Hitler hoped to win more than 50 per cent of the vote for the Nazi Party. But the party received only 43.9 per cent despite using terror to influence voters.

After the election, the Communist deputies were arrested or not admitted to the Reichstag. This gave the Nazis a majority of the seats. On March 23, 1933, the Nazi-dominated Reichstag passed a law "for the removal of distress from the people and the state." This law, known as the Enabling Act, gave the government full dictatorial powers and, in effect, suspended basic civil and human rights for four years. When the president had signed it, Hitler had a firm "legal" basis on which to govern as he pleased. He had also destroyed the constitution through outwardly legal means.

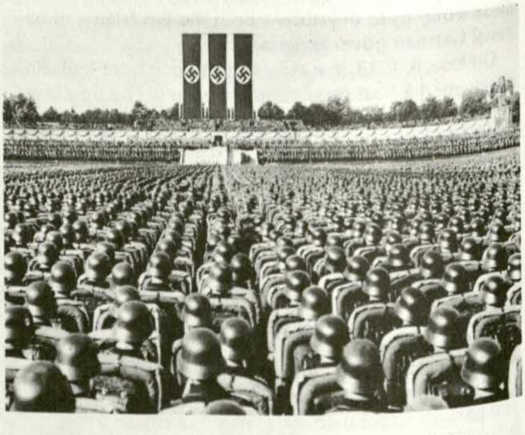
By mid-July 1933, the government had outlawed freedom of the press, all trade unions, and all political parties except the Nazis. The *Gestapo* (secret state police) hunted down the enemies and opponents of the government. People were jailed or shot on suspicion alone. By the time Hindenburg died in August 1934, Hitler ruled Germany completely. He assumed the title *Führer und Reichskanzler* (leader and reich chancellor).

The Nazis used the press, radio, and films to flood Germany with propaganda praising the *New Order,* Hitler's term for his reordering of German society and for his plans to reorder the rest of Europe. The regime applauded military training, rearmament, national pride, and industry. Jews were forced out of the civil service, universities and schools, and the professions and managerial positions. In 1935, German Jews were declared citizens of lesser rights. Thousands left the country. Many who stayed were sent to concentration camps along with hundreds of thousands of political suspects. A person needed official permission to accept work, change jobs, move, or travel abroad. The government regulated wages, housing, and production of goods. All workers and employers were supposed to belong to the German Labour Front, which was intended to replace Germany's trade unions. Through the Labour Front, the government regulated production, wages, working hours, and leisure activities.

Hitler also set up organizations for young people between the ages of 6 and 18. These groups included the *Hitler Youth* for boys 14 years and older and the *Society of German Maidens* for girls 14 years and older. The organizations were designed to condition German children to military discipline and to win their loyalty to the Nazi government. All German children were required to join such groups from the age of 10. They wore uniforms, marched, exercised, and learned Nazi beliefs.



Paul von Hindenburg, the president of Germany, named Hitler *chancellor* (prime minister) on Jan. 30, 1933. By the summer of 1933, Hitler had made himself dictator.



Nazi rallies featured thousands of troops and deeply impressed the German people. Hitler used the rallies to persuade the nation to accept his plan of conquest for Germany.

Hitler cheered the fall of France at his headquarters in Belgium on June 17, 1940.

The Nazis taught children to spy on their own families and report any anti-Nazi criticism they might hear.

A network of spies kept watch on the German people and maintained an atmosphere of terror. The Reichstag met only to listen to Hitler's public speeches. Judges and courts continued to function, but Hitler or his lieutenants reversed any decision they did not agree with.

The road to war. From 1933 onward, Hitler prepared Germany for war. He rearmed the nation, first secretly, then in open violation of the Treaty of Versailles. No nation acted to stop him, and so Hitler's steps became bolder. Hitler planned to establish Germany as the world's leading power and to destroy the Jewish people.

In 1936, Hitler sent troops into the Rhineland, again violating the Treaty of Versailles. His generals had opposed this dangerous challenge to France. But Hitler guessed correctly that France would not stop him. The stationing of German troops in the Rhineland was the first of the Nazi dictator's victories without war.

In March 1938, Hitler's troops invaded Austria. Austria then became part of Germany. In September, France and Great Britain consented to Hitler's occupation of the German-speaking areas of Czechoslovakia that had belonged to Austria-Hungary before World War I ended (see **Munich Agreement**). After this move, Hitler said he wanted no more territory. But after each success, he planned a new take-over. He took control of the rest of Czechoslovakia in March 1939.

Poland came next on Hitler's list. But Britain and France took action to try to stop any further German expansion. They guaranteed Poland's independence, saying that they would go to war against Germany if Hitler attacked Poland. Hitler doubted that they would do so. In August 1939, Germany and the Soviet Union signed treaties of friendship. They promised mutual cooperation, trade privileges, and neutrality in case of war with other countries. A secret part of the treaties divided Poland between Germany and the Soviet Union and promised the Soviet Union other territory in eastern Europe. On Sept. 1, 1939, Germany invaded Poland. Britain and France declared war on Germany two days later.

World War II. Hitler's armies overran Poland in just a few weeks. In the spring of 1940, they easily conquered Denmark, Norway, the Netherlands, Belgium, Luxembourg, and France. Benito Mussolini, Italy's dictator, declared war on France and Britain on June 10, 1940, when the defeat of France seemed certain. On June 22, 1940, France signed an armistice with Germany.

Britain fought on alone. A major German air offensive failed to weaken British resistance. Hitler kept delaying an invasion of Britain. Instead, in July 1940, he began to consider an invasion of the Soviet Union. He explained to his generals that Britain would not surrender until its last potential ally on the European continent had been defeated.

In June 1941, the attack on the Soviet Union began. At first, the German forces made rapid progress. But their advance began to slow in November. By December, it was halted outside Moscow. An unusually bitter winter, Soviet reinforcements, and supplies sent by the United States helped the Soviet forces stop the Germans and begin to push them back during the winter. Renewed German attacks in 1942 and 1943 could not break through. During the Battle of Stalingrad, which lasted for five months during 1942 and 1943, the Soviets wiped out an entire German army of 300,000 men. This German defeat was a major turning point in the war.

While his empire lasted, Hitler directed the storm troopers, Nazi officials, and members of the army and the civil service in a campaign of mass slaughter. About 6 million Jews—over two-thirds of the Jews of Europe—were murdered. More than 3 million Soviet prisoners of war were starved and worked to death. Hitler's victims also included large numbers of Gypsies, Poles, Slavs, Jehovah's Witnesses, priests and ministers, mental patients, and Communists and other political opponents.

The German resistance had tried since 1938 to kill Hitler and overthrow the Nazis. But repeated plots failed. On July 20, 1944, Hitler narrowly escaped death when a German Army officer placed a bomb in Hitler's briefing room.

Early in 1945, the Allies marched into the heart of Germany against rapidly dwindling opposition. For a detailed story of Germany in the war, see **World War II.**

Death. By April 1945, Hitler had become a broken man. His head, hands, and feet trembled, and he was tortured by stomach cramps. Eva Braun, Hitler's mistress since the 1930's, joined him at his headquarters in a bomb shelter under the Reich Chancellery in Berlin. She and Hitler were married there on April 29. The next day, they killed themselves. Aides burned their bodies. Seven days later, Germany surrendered.

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Germany (History)
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Goering, Hermann W.
Hess, Rudolf
Himmler, Heinrich
Hindenburg, Paul von
Holocaust
Jodl, Alfred
Jews (Beginnings of Nazi persecution; The Holocaust)
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Ludendorff, Erich
Mein Kampf
Mengele, Josef
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Nazism
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Propaganda (Simplicity and repetition; pictures)
Ribbentrop, Joachim von

Rommel, Erwin
Rosenberg, Alfred
Stalingrad, Battle of
Swastika
War crime
World War II

Outline

- **I. Early life**
  - A. Boyhood
  - B. Years in Vienna
  - C. Corporal Hitler
- **II. Rise to power**
  - A. Birth of the Nazi Party
  - B. The Beer Hall Putsch
  - C. *Mein Kampf*
  - D. Rise of the Nazis
- **III. Dictator of Germany**
  - A. The New Order
  - B. The road to war
  - C. World War II
  - D. Death

Questions

As a young man, what did Hitler want to study?
What was the Beer Hall Putsch? *Mein Kampf*?
Why was Hitler named chancellor of Germany?
How did Hitler touch off World War II?
How did Hitler win the support of the German people?
What were Hitler's main goals as dictator?
Why did Hitler order the invasion of the Soviet Union during World War II?
How did Hitler set young Germans against their parents?
As a boy, how did Hitler anger his father?
Why did no nation challenge Hitler before 1939?

Hittites were the earliest known inhabitants of what is now Turkey. They began to control the area about 1900 B.C. During the next several hundred years, they conquered parts of Mesopotamia and Syria. By 1500 B.C., the Hittites had become a leading power in the Middle East. Hittite culture and language were Indo-European, but scholars do not know whether the Hittites came from Europe or from central Asia.

Way of life. Many elements of Hittite architecture, art, literature, and religion were influenced by neighbouring peoples. The Hittites' system of government was more advanced than that of many of their neighbours. Their legal system was fair and humane, and their law code emphasized compensation for a wrong, rather than revengeful punishment. The Hittites established peaceful and profitable relations with the peoples they conquered. Their military superiority resulted from several innovations. The Hittites were among the first to smelt iron. They also built the lightest and fastest chariots of their time.

The Hittites used the Akkadian language (the language of Babylonia) written in cuneiform for their international correspondence. For their own royal and religious writings, they used the Hittite language recorded either in Hittite hieroglyphic writing or in cuneiform script borrowed from the Mesopotamians. Scholars deciphered the cuneiform in the early 1900's. But the scholars could not definitely decipher the hieroglyphs until 1947, when they found lengthy statements in both the Phoenician language and Hittite hieroglyphs. These bilingual documents provided scholars with the key for translating Hittite hieroglyphs.

History. The Hittites penetrated what is now central Turkey shortly after 2000 B.C. They conquered the local people and set up a number of city-states. The most important of these was Hattusas, located just east of the present Turkish capital, Ankara. When the city-states formed the Hittite empire, about 1650 B.C., Hattusas became the capital.

A Hittite banquet appears in relief on this stone slab, which was carved during the 800's B.C.

The Hittites conquered Babylon about 1595 B.C. They also gained control of northern Syria. The widow of an Egyptian pharaoh, probably Tutankhamen, asked the Hittite emperor to send one of his sons to be her husband and pharaoh of Egypt. But a group of Egyptians who did not like this arrangement murdered the son before the marriage.

One of the greatest battles of ancient times took place about 1285 B.C. at Kadesh on the Orontes River, north of Palestine. Mutwatallis, the Hittite leader, fought an indecisive battle against Egyptian forces under Ramses II, who barely escaped alive. The Hittites did not conquer Egyptian territory. They concluded a peace that was sealed by the marriage of a Hittite princess to Ramses. See **Ramses II.**

Shortly after this, allies of the Hittites in both east and west revolted. Tribes migrated from their homes around the Aegean Sea into the western part of the Hittite empire to escape the growing power of the Greeks. They burned Hattusas in about 1200 B.C. Hittite city-states continued to exist for another 500 years, but they were not very powerful. Carchemish came to be considered the eastern capital of the Hittites. But Sargon II of Assyria captured it in 717 B.C. This marked the end of a distinct Hittite government.

The Hittites are mentioned several times in the Old Testament of the Bible. Abraham bought the field and cave of Machpelah from Ephron the Hittite as a burial place for his wife Sarah. Abraham's grandson, Esau, married two Hittite wives. As late as the time of David, certain people of Israel were called Hittites. David had Uriah the Hittite killed in battle so that he could marry Uriah's wife, Bathsheba.

Hives are a form of skin rash that appears suddenly and disappears without leaving a trace. Hives are usually a reaction to *histamine,* a substance in the body that often causes allergy. The rash consists of white or red *wheals* (raised patches) that itch. See **Allergy; Itch.**

Hives may be caused by a variety of substances to which the sufferer is allergic, such as a food or drug, or a substance that is inhaled, such as dust or pollen. People also may become allergic to a substance after they come in contact with it. For example, they may become allergic to chemicals they touch frequently or to an animal's fur. An outbreak of hives often may be treated with antihistamine drugs or by bathing the spots with bicarbonate of soda and water, witch hazel, or some other cooling solution.

Hives are also known as *nettle rash.* The medical name for hives is *urticaria.*

Hluhluwe is a South African game reserve located in Kwazulu-Natal, 280 kilometres north of Durban. The park is a popular tourist resort with various types of accommodation. The reserve covers an area of about 23,000 hectares. The area has a temperate climate, with an average annual rainfall of 75 centimetres.

Hluhluwe is renowned for its rhinoceros population, both black and white. Other animals in the reserve include antelopes, baboons, buffaloes, cheetahs, crocodiles, giraffes, hippopotamuses, leopards, lions, and zebras. There are various types of birds and reptiles.

The name of the reserve originates from the Hluhluwe River, which flows through it. *Hluhluwe* is a Zulu word for the creepers which grow on the river banks. Hluhluwe was one of the first areas set aside for the conservation of wildlife in South Africa. Hunters and poachers had destroyed most of the game in the area during the late 1800's. To conserve the animals, the park was designated in 1895 and established in 1897.

Ho Chi Minh (1890-1969), a Vietnamese revolutionary leader, served as president of North Vietnam from 1954 until his death. Ho gained popularity when his forces defeated the French rulers of Vietnam in 1954. In the 1950's and 1960's, Ho's Communist government sent troops to aid rebels in South Vietnam who were trying to overthrow the anti-Communist government there. Ho's followers continued to aid the rebels after his death and, in 1975, the Communist forces won control of South Vietnam.

Ho Chi Minh

Ho was born Nguyen Van Thanh in central Vietnam. He became a Communist in 1920, and helped found the French Communist Party. Near the end of World War II (1939-1945), Ho became head of a Vietnamese government that opposed France's rule.

In 1946, fighting broke out between the French and Ho's troops, known as the Vietminh. After the Vietminh defeated the French in 1954, an international conference divided Vietnam into two nations. Ho then became president of North Vietnam.

See also **Indochina** (Independence); **Vietnam** (History); **Vietnam War.**

Ho Chi Minh City (pop. 3,934,395), formerly called Saigon, is the largest city in Vietnam. It is also a leading Vietnamese industrial and commercial centre. Ho Chi Minh City lies in southern Vietnam, between the Mekong River Delta and the South China Sea. For location, see **Vietnam** (map). The delta is a fertile agricultural region. Products from the delta are sent to Ho Chi Minh City for shipment.

Treelined boulevards beautify the centre of Ho Chi Minh City and of Cholon, a largely Chinese section of the city. Ho Chi Minh City has much modern architecture, as well as many old Chinese and French-colonial buildings. The University of Ho Chi Minh City is the largest institution of higher learning in Vietnam.

In the 1700's, Vietnamese who had migrated from the north used the city, then called Saigon, as a port to ship back rice grown in the Mekong River Delta. The French took control of Saigon in 1861. They made it a military base and the administrative capital of their colony of Cochin China (see **Indochina** (French Indochina).

In 1954, Indochina gained independence from France. The Vietnamese parts of the colony were divided into two countries—South Vietnam and North Vietnam. Saigon became the capital of South Vietnam.

Saigon grew tremendously during the Vietnam War (1957-1975). Thousands of South Vietnamese and United States troops were stationed there, and many people moved there to escape fighting in the countryside. Communist North Vietnam defeated South Vietnam in the war. The Communists united the North and South into the single nation of Vietnam in 1976. They changed Saigon's name to Ho Chi Minh City, in honour of the former president of North Vietnam. Since the end of the war, the city's economy has declined somewhat and unemployment has increased. The government has forced many people to leave the city and to work in rural areas.

Hoad, Lew (1934-1994), an Australian tennis player, won the Wimbledon men's singles title in 1956 and 1957. In 1956, he won the Australian and French singles titles. He and Ken Rosewall won the Davis Cup for Australia in 1953, 1955, and 1956. Lewis Alan Hoad became a professional player in 1957. He was born in Sydney.

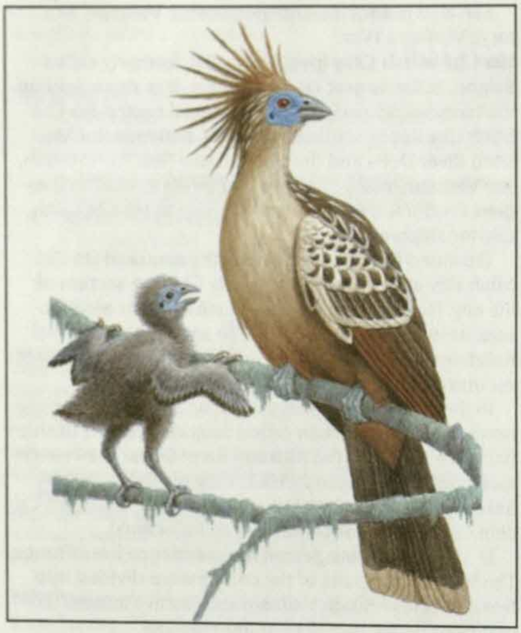
Hoarfrost. See **Frost.**

Hoarhound. See **Horehound.**

Hoatzin is an unusual bird that lives in marshy areas by waterways in northern South America. Hoatzins have claws on their wings when they hatch. The young birds use the claws to climb on tree branches until they learn to fly. The claws fall off as the birds mature.

The hoatzin has short, rounded wings and a long tail. It has bright red eyes, a blue face, and a stiff crest of brown feathers atop its head. The bird's upper body is dark brown, and its underparts are a dull yellow. The hoatzin is the size of a small chicken.

Among birds, hoatzins have a unique digestive system that uses more than one compartment to break down food. Hoatzins store and partially digest their food, mostly leaves, in a *crop* (baglike organ) before it reaches the stomach. This digestive process is similar to that of such grazing mammals as cows and deer, a fact that puzzles scientists. Hoatzins live in family groups in tree branches that hang over marshy waters.



The strange-looking hoatzin lives in South America. A young hoatzin has claws on its wings, which help the bird climb trees before it can fly. Adults have long, loose feathers on their head.

Scientific classification. Hoatzins make up the hoatzin family, Opisthocomidae. They are classified as *Opisthocomus hoazin.*

Hobart (pop. 47,109; met. area pop. 181,838) is the capital of the state of Tasmania, Australia. It is in the southeastern part of the state on the estuary of the Derwent River. Greater Hobart is a statistical division, which includes the city of Glenorchy and nearby districts such as Clarence, Kingborough, Brighton, Sorell, and New Norfolk. The area of Hobart city is about 78 square kilometres. Hobart is 735 kilometres by sea from Melbourne. By air the journey takes about one and a half hours.

Average annual rainfall is 660 millimetres. The average January temperature is 21° C. July temperatures average 11° C.

Hobart attracts many tourists. It is the finish for both the 1,100-kilometre Sydney-to-Hobart yacht race and the Melbourne-to-Hobart race along the west coast of Tasmania. Both of these races start on Boxing Day (December 26).

Hobart's central business area includes many high-rise office buildings, shops, and department stores. Industrial areas are located away from the commercial centre, with heavy industry concentrated around Moonah and Glenorchy. Residential areas include the suburbs of Risdon Vale, Warrane, Springfield Gardens, Chigwell, and the older suburbs of New Town, Lenah Valley, Sandy Bay, and Taroona. A fast-growing housing area is made up of Bridgewater, Herdsmans Cove, and Gagebrook, situated about 20 kilometres from the city centre.

Places of historic interest abound in Hobart. At Salamanca Place, sandstone warehouses and stores have been converted to tourist shops and restaurants. Close by is Battery Point, the site of an old gun battery set up to defend the port. A number of Georgian cottages in Arthur's Circus, built between 1847 and 1852, are still used as private houses. Battery Point, with its fine early houses, is being preserved for its historic interest.

Hobart has some interesting architecture. It includes the Victorian Theatre Royal (1834) and Old Trinity Church (both designed by colonial architect John Lee Archer), the Lady Franklin Museum (1843), and St. George's Church. The Shot Tower in Taroona was built in 1870. Hobart's most famous modern building is Australia's first legalized gambling casino at Wrest Point, opened in 1973.

People. By far the largest number of people who live in Greater Hobart are of British origin. Since World War II (1939-1945), sizeable Dutch, Greek, Italian, and Polish communities have grown up in and around Hobart.

Economy. A large workforce is employed on Hobart's deep-water port with its extensive cargo-handling facilities. Many people are employed in service occupations and by government departments. The Cascade Brewery has been making beer since 1824. A company at Risdon produces about 65 per cent of Australia's refined zinc. Newsprint mills at Boyer supply almost half Australia's needs. The biggest cocoa and confectionery factory in Australia is located at Claremont.

Education and libraries. Hobart's oldest school is the Hutchins School, founded in 1846. Most schools are run by the state government. The University of Tasmania, established in 1890, has more than 6,000 students. Hobart also has a technical college. The Hobart State Library is the city's chief library.

Government. Hobart is governed by a city council consisting of 12 aldermen who are elected for a four-year term, and a lord mayor and deputy lord mayor elected for a two-year term. The city of Glenorchy, which is included in Greater Hobart, is also governed by a council made up of an elected mayor, deputy mayor, and councillors.

Water supplies. Hobart's water comes from Lake Fenton and Mount Wellington. Supply is controlled by the Metropolitan Water Board. A treatment plant at Bryn Estyn, near New Norfolk, pumps water from the Derwent River for Hobart's eastern suburbs.

Transport. Hobart is a centre of road, rail, air, and sea transport for Tasmania. The Metropolitan Transport Trust (M.T.T.) controls public transport in the city. Hobart's airport is at Llanherne, 18 kilometres east of the city.

History. Tasmania was first visited by Europeans in 1642. In 1803 a British settlement was made at Risdon Cove. In February 1804, Lieutenant governor David Collins abandoned the settlement at Risdon Cove. With a group of soldiers, convicts, and free settlers, he established a new settlement at Sullivan's Cove.

The settlers numbered 226 men, 15 women, and 21 children. The city is named after Lord Hobart, a British secretary of state for the colonies. Lieutenant governor George Arthur led a period of rapid development after he arrived in 1824. Local industries began to develop. Hobart became a city in 1842. The last convicts arrived in 1853. In 1856, Hobart was the site of Tasmania's new state House of Assembly and Legislative Council.

Bushrangers (outlaws) and Tasmanian Aborigines

Hobart stands on the Derwent River below Mount Wellington. Snow caps the 1,270 metre mountain during the coldest months.

caused trouble to the Hobart settlers. Truganini, one of the last full-blooded Tasmanian Aborigines, died at Hobart in 1876. Much new development took place in the 1900's. The Tasman Bridge was opened in 1964, replacing an older floating bridge. In 1984, Bowen Bridge was opened. Bushfires invaded Hobart on Feb. 7, 1967, now known as *Black Tuesday,* killing 62 people.

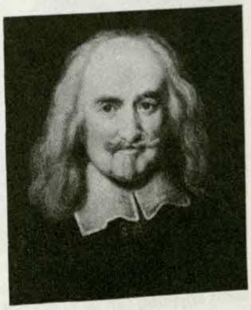
Related articles in ***World Book*** include:

Archer, John Lee
Brady, Matthew
Collins, David
Knopwood, Robert
Robinson, George Augustus
Tasmania
Truganini

Hobbes, Thomas (1588-1679), was an English philosopher. His most famous work, *Leviathan, or the Matter, Form, and Power of a Commonwealth, Ecclesiastical and Civil* (1651), was concerned with political theory. In this work, he denied that people are naturally social beings. He argued instead that people are basically selfish.

Hobbes was influenced by two developments of his time. One was the new system of physics that Galileo and others were working out (see **Galileo**). From their ideas, Hobbes concluded that only matter exists and that everything that happens can be predicted in accordance with exact, scientific laws. Many people believed that his view denied the existence of God and a free human soul that is immortal. But Hobbes denied this.

The second great influence on Hobbes's thought was the English Civil War. People, he concluded, are selfish. They are moved chiefly by desire for power and by fear of others. Thus, without an all-powerful sovereign to rule them, their lives would be "poor, nasty, brutish, and short."



Thomas Hobbes

Hobbes's influence. Though modern physics is not so materialistic as it seemed to be in Hobbes's day and though human motives are more complex than he supposed, Hobbes's influence continues. He raised fundamental and challenging questions about the relationship between science and religion, the relationship between thought and the physiological processes on which it is based, and the nature and limitations of political power. The questions that Hobbes raised are ones that people still struggle to answer.

His life. Hobbes was born in Westport (now part of Malmesbury), England. He was educated at Oxford University, and served as secretary to Sir Francis Bacon and as tutor to William Cavendish, who later became Earl of Devonshire. Hobbes travelled widely with Cavendish and met many European philosophers and scientists.

During the English Civil War, Hobbes fled to the European continent. For a short time, he tutored the Prince of Wales, later Charles II, in mathematics. Although Hobbes returned to England while Oliver Cromwell's Protectorate was still in power, he was befriended by Charles II when Charles became king in 1660.

Hobble skirt. See **Clothing** (The 1900's).

Hobbs, Sir John (1882-1963), was one of the greatest English batsmen in cricket. He scored a world record total of 61,237 runs, including 197 centuries. Hobbs began playing cricket at the late age of 22. In 1907, he played in the first of his 61 test matches against Australia, scoring 83 in his first innings. His highest score was 316 at Lord's in 1926, for Surrey against Middlesex. Hobbs was born in Cambridge and was named John Berry Hobbs. He was usually called *Jack.* He was knighted in 1953.

Hobby can be any type of activity people do during their leisure time. Most people take up a hobby for relaxation, pleasure, or friendships, or to develop new interests. Sometimes a hobby can lead to extra income.

People of almost any age can enjoy hobbies. A hobby offers a way to relax after periods of hard work. Hobbies

Painting is a popular hobby that provides opportunities for self-expression and creativity. The hobbyist shown above is painting an outdoor landscape scene.

offer broadened areas of interest and ways to pass the time pleasantly. Hobbies can be important in helping patients recover from physical or mental illness because they provide distractions from the patients' problems. For people who are ill or bedridden, hobbies offer fascinating ways to pass the time. Hobbies can also be an important form of occupational therapy.

In the past, hobbies were largely limited to the wealthy. The average person was too busy earning a living to find time to pursue a hobby. People today generally have more leisure time because of higher incomes and improvements in working conditions. In addition, most people live longer and retire from their jobs at an earlier age. To fill their free time, they often develop interests in hobbies.

Kinds of hobbies

Almost any kind of leisure activity can become a hobby. Most hobbies fall into one of four general categories, which may overlap. They are (1) the arts, (2) collecting, (3) handicrafts, and (4) games and sports.

The arts provide outlets for hobbyists with a special interest in such art forms as dancing, drama, painting, graphic arts, and music. Each art form has many separate possibilities for a hobby. For example, music may include singing, playing an instrument, collecting records and tapes, learning ballet, or attending concerts and operas. Painting offers the hobbyist a wide choice of materials, such as oil paints or water colours.

Collecting is probably the most widespread kind of hobby because almost anything can be collected. Stamps and coins are probably the most popular collected items. Hobbyists also collect such things as autographs, comic books, costumes, buttons, dolls, shells, stamps and train numbers.

Handicrafts attract hobbyists who can work skilfully with their hands. Many hobbyists engage in needlework activities, notably crocheting, needlepoint, knitting, and sewing. Hobbyists use kits to make model aeroplanes, boats, and trains. Using woodworking tools, they can create carvings, furniture, and bowls. Other handicrafts include ceramics, metalworking, jewellery making, weaving, batik, and leatherworking.

Games and sports are popular with many hobbyists who enjoy competition, physical activity, and exercise. Thousands of hobbyists take part in sports, such as bowling, fishing, mountain climbing, skiing, and tennis. These sports give hobbyists the opportunity to display their individual skills and sportsmanship. Popular indoor games include bridge and other card games, backgammon, chess, and Monopoly.

Other hobbies, Electronics-related hobbies are becoming increasingly popular. Many hobbyists enjoy flying model aeroplanes by remote control or assembling and operating ham radios. Both young people and adults have taken up computers as a hobby. They can spend many hours playing computer games. Some people raise pets as a hobby. For many people, gardening and photography are rewarding hobbies.

Starting a hobby

People sometimes choose a hobby without realizing they are doing so. A casual interest grows into a fascination as the person learns more about the subject and devotes an increasing amount of time to it. After deciding on a hobby, individuals may gather as much information as they can from reference sources, especially books and magazines. They can also gain information by taking courses in school, attending hobby conventions, and joining hobby clubs. Hobbyists often can study ex-

Collecting is probably the most widespread kind of hobby. Almost anything can be collected. People who collect stamps often mount them in an album.

Quilting is a popular handicraft throughout the world. Many people design and sew colourful quilts as a hobby. The woman shown above is stitching a patchwork quilt.

hibits relating to their hobby in museums and galleries. Clubs and other organizations sponsor tours that allow hobbyists to visit places where they can pursue their hobby and meet people with similar interests.

In most cases, beginning hobbyists should start with a few basic items. As they become more experienced and enthusiastic, they may buy more elaborate materials. Hobby dealers provide information about equipment, supplies, and techniques.

Related articles in *World Book* include:

Arts hobbies

Art and the arts
Dancing
Drama
Drawing
Finger painting
Literature
Music
Orchestra
Painting
Poetry
Reading
Singing
Theatre

Collection hobbies

Antique
Aquarium
Autograph
Book collecting
Butterfly
Button
Car
Coin collecting
Doll
Flower
Fossil
Furniture
Insect
Leaf
Moth
Pet
Rock
Shell
Stamp collecting
Tropical fish

Handicraft hobbies

Aeroplane, Model
Appliqué
Basket making
Beadwork
Block printing
Bookbinding
Car, Model
Ceramics
Cooking
Crewel
Crocheting
Decal
Decoupage
Embroidery
Handicraft
Jewellery
Kite
Knitting
Leathercraft
Macramé
Mosaic
Needlepoint
Papier-mâché
Petit point
Photography
Pottery
Puppet
Quilt
Railway, Model
Rocket, Model
Rugs and carpets
Sampler
Sewing
Ship, Model
Silk-screen printing
Taxidermy
Weaving
Woodcarving
Woodworking

Games and sports

See the lists of *Related articles* with **Game; Play; Sports.**

Other hobbies

Astronomy
Bee
Bird (Bird study)
Computer
Film industry
Gardening
High fidelity system
Radio, Amateur
Ventriloquism

Hobby. See Falcon.

Hobson, John Atkinson (1858-1940), was an English economist and journalist. He believed that economic thinking must be closely connected with human welfare so that it can lead to reform. He taught the need for a degree of socialism in government. His writings include *The Science of Wealth* (1911), *Wealth and Life* (1920), *Free Thought in the Social Sciences* (1926), and *Confessions of an Economic Heretic* (1938). Hobson was born in Derby and educated at Oxford University.

Hochhuth, Rolf (1931-), is a German playwright. His plays dramatize questionable moral decisions made by famous people of modern history. In his most famous play, *The Deputy* (1963), also known as *The Representative,* Hochhuth condemned Pope Pius XII for not protesting against the Nazi extermination of Jews during World War II (1939-1945).

In his second play, *Soldiers* (1967), Hochhuth charged the British Prime Minister Winston Churchill with causing the death of General Władysław Sikorski, leader of Poland's government in exile. He asserted that Churchill had Sikorski killed for diplomatic reasons. He also portrayed Churchill as insensitive to the deaths of German civilians in cities bombed by the Allies.

In *Guerrillas* (1970), Hochhuth charged the United States with racial and political murders. This play portrays fictional public figures in the United States and Latin America. Hochhuth was born in Eschwege, near Kassel, Germany.

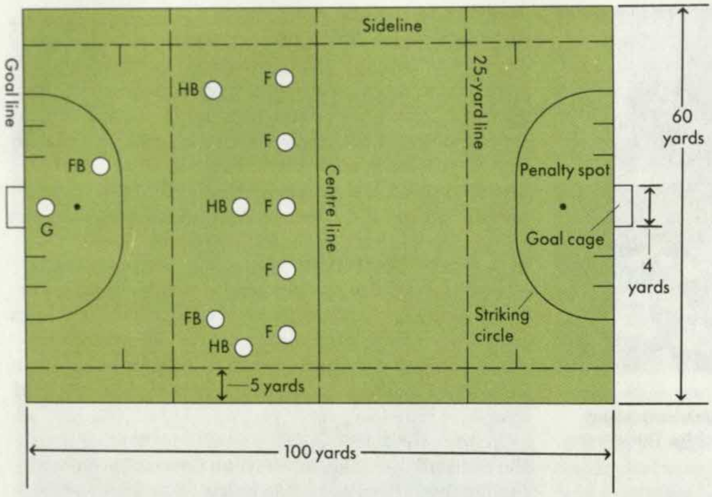
Höchstädt, Battle of. See **Blenheim, Battle of.**

Hockey is a fast and exciting team sport in which players use sticks to try to hit a ball into their opponents' goal. In some countries, hockey is played primarily by girls and women, but it is also a popular male sport. In North America, hockey is the term used for ice hockey (see **Ice hockey**).

The field and equipment. The teams compete on a smooth grass or artificial turf field 91 metres long and 55 metres wide. Various lines divide the field into sections. A *goal line* runs across the width of the field at each end. A wide arc called a *striking circle* extends from each goal line. A centre line parallel to the goal lines divides the field in half.

A goal cage stands in the centre of each goal line. The

Hockey is a fast-moving team sport. Players try to hit a ball toward their opponents' goal, using sticks curved at one end. A goalkeeper tries to block shots before they go into the goal.



A hockey field is divided into two halves by a solid centre line. Two broken 25-yard (23 metre) lines run parallel to the centre line and to a goal line at each end of the field. A broken line runs the length of the field 5 yards (4.6 metres) from each sideline. In a game, goals must be scored from within the striking circle.

cage has two goal posts 7 feet (2.13 metres) high and 12 feet (3.66 metres) apart. The posts are connected by a crossbar. A net is attached to the posts and crossbar. A backboard 18 inches (46 centimetres) high and 4 yards (3.7 metres) long is placed inside the net. Sideboards at least 4 feet (1.22 metres) long and 18 inches (46 centimetres) high are attached to the backs of the goal posts at right angles to the goal line.

Each player carries a stick with a curved end that is flat on its left side and rounded on its right. Only the flat side may be used to hit the ball. Most players use sticks that vary from 86 to 94 centimetres in length. The ball is about 23 centimetres in circumference and weighs about 160 grams. It has a rubber centre and a polyurethane covering.

The game is divided into two halves, each of 35 minutes. At half time the players change ends. There is an interval of 5 minutes. Each team has 11 players. The basic formation consists of five forwards, three halfbacks, two fullbacks, and a goalkeeper. Two umpires supervise the game, sometimes assisted by one or two timekeepers.

Players try to move the ball using only their sticks until they are in a position to shoot it into the other team's goal. Each goal counts 1 point. A goal is scored each time an attacking player hits the ball from within the striking circle so that it crosses the goal line between the goal posts and under the crossbar. The team that scores the highest number of goals will be the winners.

The game starts with a *passback.* A player from one team hits or pushes the ball with the stick from the centre line to a teammate. At the time of the passback, no players of the opposing team may be within 4.5 metres of the ball. All players except the one executing the passback must remain in their own half of the field. The ball may not cross the centre line. Play resumes with a passback after each goal.

The rules allow no body contact or dangerous hitting and prohibit a player from playing a ball above shoulder height with any part of the stick. The goalkeeper may kick the ball or stop it with any part of the body, including the hand, but only when the ball is inside the striking circle. The referee declares a penalty if any of these rules is broken.

After a penalty, the game may be restarted with a free hit. But, if the referee judges that two players were guilty of a breach of the rules at the same time, the game is restarted with a *bully.* For a bully two players stand facing each other, with the ball on the ground between them. Each player must tap his stick on the ground, then tap his opponent's stick. This must be done three times and then either of the players may hit the ball.

Hockey in Australia and New Zealand. Hockey is a popular sport in Australia. A state hockey association controls the game in each state. These associations belong to the national Australian Hockey Association, which has a membership of more than 70,000 men players, or the Australian Women's Hockey Association, which has a membership of about 30,000 women.

Hockey was first played in South Australia in 1904. State teams compete in the Australian Hockey Championships, held by national associations each year. Australia won third place at the Tokyo Olympics in 1964 and was second in the Mexico Olympics in 1968 and the Montreal Olympics in 1976. In men's hockey, Australia won the ESANDA world hockey title in 1982, the Raja Azan Cup in 1983, and the PIA champions trophy in 1983, 1984, and 1985. Australian women first competed in international hockey in 1914, when a British team toured Australia. The first women's team to play overseas competed in South Africa in 1930. Since that time, Australian women have competed against many of the world's leading teams. In 1988, they were the Olympic women's champions.

In New Zealand, hockey rates next in popularity after rugby football and soccer as a winter sport. More than 14,000 men belong to the 25 associations connected with the New Zealand Hockey Association. The New Zealand Women's Hockey Association controls the game for about 12,000 women. The major competitions are for the Challenge Shield (for men), and the Izard and K cups (for women). Hockey was first played at Christchurch in 1896, and soon became popular. New Zealand teams finished sixth in the Olympic Games in 1956, and

In hockey the ball is controlled with a stick. A player may not hit a ball that is above shoulder height.

fifth in 1960. New Zealand beat Australia in the final of men's hockey in the 1976 Olympics.

Hockey in India and Pakistan. An ancient form of stick and ball game had been played in India for hundreds of years when British servicemen first took the game of hockey there in the 1880's. The first hockey clubs were established in Calcutta in 1885, and the game spread rapidly to all parts of the country. The most important competitions were the Beighton Cup and the Aga Khan Tournament.

An Indian hockey federation was founded in 1925, in Gwalior, and an Indian team first took part in the Olympic Games in Amsterdam in 1928. The team won every game and was awarded the gold medal. India won the gold medal again in the Olympic Games of 1948, 1952, 1956, and 1964. During the 1960's, Pakistan was successful in taking the gold medal from the Indian team. Pakistan won in 1960, and in 1968. India were the gold medallists again in 1980, but Pakistan won once again in 1984.

In the hockey World Cup, these two countries were at the forefront of international competition for many years. India won the World Cup in 1975, and Pakistan, which had won in 1971, regained the cup in 1978 and 1982.

Hockey in the United Kingdom is a popular game. Many girls' schools and clubs belong to the All England Women's Hockey Association. The most important matches of the season in women's hockey are international matches between England and either an overseas country or another country in the UK.

In men's hockey in the UK, the chief organization is the Hockey Association, which has many affiliated schools and clubs. National championship contests for men's hockey teams are a county championship, a club championship, and an indoor club championship.

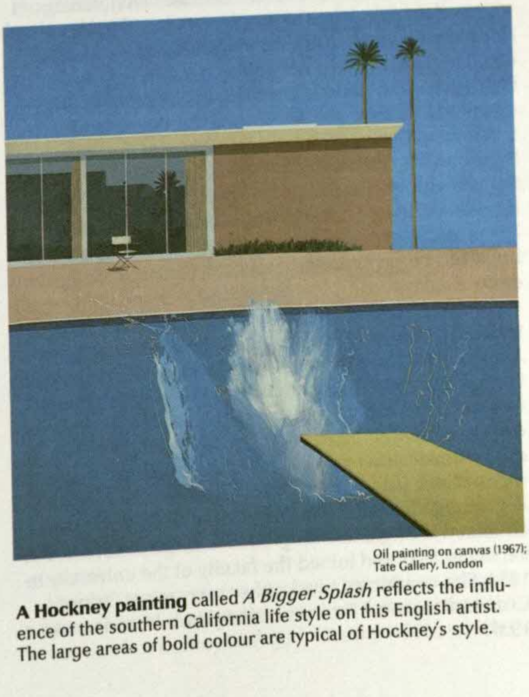
In 1908, the first year that men's hockey was included in the Olympic Games, England beat Ireland in the final match. In the 1984 Olympic Games, the British men's team beat Australia to win the bronze medal. In 1988, the UK hockey team became the Olympic champions.

One of the earliest references in England to a game resembling hockey was in 1175, when William Fitzstephen wrote of London schoolboys playing *ball in the field.* In Canterbury and Gloucester cathedrals, stained-glass windows of the 1300's show boys playing with hockey sticks and hockey balls. The first English hockey club was formed at Blackheath, London, in 1861.

History. The origin of hockey is not known. Ancient Greek carvings show players using crooked sticks to hit a small object. Only men played hockey for many years. In 1889, the All England Women's Hockey Association was established. Men's hockey has been part of the Summer Olympics since 1908. Women's hockey became an Olympic sport at the 1980 Summer Games. Rules are made by the International Hockey Rules Board and are the same for men and women.

Hockey, Ice. See **Ice hockey.**

Hockney, David (1937-), an English artist, became famous in the 1960's for his bold, unconventional pictures. Hockney made his first impact on the art world as a leader of the English pop art movement. He has become the most internationally famous British artist of his time. Hockney is essentially a realistic painter and much of his art is autobiographical, relating to his own life and the lives of his friends. He is a versatile artist, often exploiting such techniques as photography in the composition of his paintings. Hockney became one of the first artists to explore the artistic potential of modern technology, such as facsimile machines, in his works. Hockney is also noted for his photographs, drawings, and prints. In 1963, he moved to Los Angeles. Many of Hockney's paintings are inspired by southern California's blue skies, sunny climate, and culture of swimming pools and pleasure-seeking life styles. Hockney's California paintings illustrate his characteristic use of large areas of bold colour.



Oil painting on canvas (1967);
Tate Gallery, London

A Hockney painting called *A Bigger Splash* reflects the influence of the southern California life style on this English artist. The large areas of bold colour are typical of Hockney's style.

Hockney's pictures have been exhibited in galleries and museums all over the world. In the 1970's and 1980's, he designed theatre and film sets. These included the sets for the Glyndebourne productions of Mozart's opera *The Magic Flute* and Stravinsky's opera *The Rake's Progress.* In 1974, he appeared in *A Bigger Splash,* a film about his life. Hockney's work also appears in several autobiographical books.

Hockney was born and educated in Bradford, West Yorkshire. He attended the Bradford College of Art and the Royal College of Art, in London.

Hoddinott, Alun (1929-), a Welsh composer, became professor of music at University College, Cardiff, in 1967. His works, mostly modern in idiom, include *Variants* and *Night Music* (both 1966). Some pieces reflect Hoddinott's Welsh background, notably two suites of *Welsh Dances* (1958 and 1969). Hoddinott's operas include *The Beach of Falesá* (1974) and *The Trumpet Major* (1981). Hoddinott was born in Bargoed, Mid Glamorgan, and went to university in Cardiff.

Hoddle, Robert (1794-1881), was a pioneer surveyor in Australia. He is remembered mainly for his design of Melbourne, completed in 1837. He planned the city in a gridiron pattern, with the main streets 30 metres wide. Sir Ralph Darling, the governor, appointed him assistant surveyor in 1826. In 1851, Hoddle became the first surveyor general of the new colony of Victoria. He surveyed many areas for settlement, including Campbelltown, Berrima, and Goulburn. He worked with the explorer John Oxley in mapping and surveying the shores of Moreton Bay. He also surveyed the upper Shoalhaven River area. He was born in London. He settled in Australia in 1823.

Hodgkin, Sir Alan (1914-), a British physiologist, shared the 1963 Nobel Prize for medicine for his research into nerve impulses. He shared the prize with John Eccles and Andrew Huxley. He was president of the Royal Society from 1970 to 1975. He was knighted in 1972 and awarded the Order of Merit in 1973. Alan Lloyd Hodgkin was born in Banbury, Oxfordshire, and educated at Cambridge.

Hodgkin, Dorothy Crowfoot (1910-1994), a British chemist, won the 1964 Nobel Prize for chemistry for determining the highly complex structure of the vitamin B_{12} molecule. She started this work in 1948, using X rays to make this important discovery. Knowledge of the molecular structure of vitamin B_{12} has enabled scientists to better understand how the body uses this substance to build red blood cells and prevent a disease called *pernicious anaemia.*

Hodgkin devoted her career to studying the structures of complex substances through a method called *X-ray crystallography* (see **X rays** [In scientific research]). During the 1940's, she determined the molecular structures of cholesterol iodide, penicillin, and other related organic compounds. In 1969, she revealed the three-dimensional structure of insulin, the pancreatic hormone which is important in regulating blood sugar.

Dorothy Crowfoot was born in Cairo, Egypt, and was educated in England. She graduated from Oxford University in 1931 and joined the faculty of the university in 1934. She conducted most of her research at Oxford. Crowfoot married Thomas L. Hodgkin, a historian, in 1937.

Hodgkin's disease is a type of cancer in which the lymph nodes become enlarged (see **Lymphatic system**). Other lymphoid tissues, such as the spleen, may also become swollen. Most victims of Hodgkin's disease are 20 to 40 years old. The disease, which strikes more men than women, may be fatal. The cause of Hodgkin's disease is unknown.

Beginning in the 1960's, medical researchers discovered much about Hodgkin's disease and how to control or even conquer it. They learned that the disease (1) spreads in a fairly predictable way from one group of lymph nodes to the next; (2) takes a relatively long time to spread to other areas of the body; (3) can usually be treated successfully with X rays in early stages; and (4) can sometimes be treated successfully with drugs or with bone marrow transplantation in advanced stages. Hodgkin's disease resembles other diseases that also cause swelling of the lymph nodes. Doctors identify the condition by the presence in the swollen tissue of large cells called *Reed-Sternberg cells.* Most of these large cells have two nuclei. Hodgkin's disease was first described by Thomas Hodgkin, an English doctor, in 1832.

Hoffman, Dustin (1937-), is an American actor best known for his offbeat character roles in unusual and demanding films. Hoffman won Academy Awards as best actor for his performances in *Kramer vs. Kramer* (1979) and *Rain Man* (1988).

Dustin Lee Hoffman was born in Los Angeles and studied acting at the Pasadena Playhouse. In 1958, he moved to New York City, where he appeared in several plays. Hoffman first won fame for his role in *The Graduate* (1967).

Dustin Hoffman

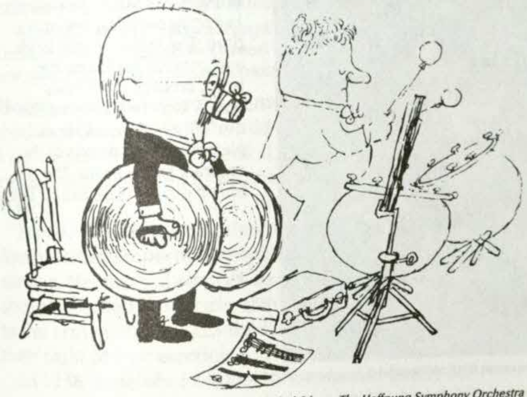
Hoffman played an Indian scout in the Western *Little Big Man* (1970). He starred as the controversial comedian Lenny Bruce in *Lenny* (1974) and appeared in the political thriller *All the President's Men* (1976). Hoffman played the role of a man impersonating a woman in the comedy *Tootsie* (1982). Hoffman's other films include *Midnight Cowboy* (1969), *Straw Dogs* (1971), *Papillon* (1973), *Marathon Man* (1976), *Straight Time* (1978), and *Ishtar* (1987). Hoffman returned to the stage in 1984 to star in a highly praised revival of the American drama *Death of a Salesman* (see **Drama** [picture: Willy Loman]). He also played Shylock in Shakespeare's *The Merchant of Venice* in London and New York in 1989 and 1990.

Hoffmann, Ernst Theodor Amadeus (1776-1822), was a German writer. He mingled weird and fantastic events with situations of everyday life. Hoffmann's imaginative blend of romanticism and realism influenced Edgar Allan Poe and Charles Baudelaire. Some of Hoffmann's stories were collected in *Fantastic Tales* (1814-1815) and *Night Pieces* (1816-1817). His novels include *The Elixirs of the Devil* (1815-1816) and *Views on Life of the Tomcat Murr* (1819-1821). His *Mademoiselle de Scudéry* (1819) was a forerunner of the detective story.

Hoffmann was born in Königsberg, Germany (now

Kaliningrad, Russia). He was an author, cartoonist, composer, musician, opera director, and orchestra conductor. His life and works inspired Jacques Offenbach's opera *The Tales of Hoffmann.*

Hoffnung, Gerard (1925-1959), was a British humorist, artist, musician, and public speaker. He won great popularity with his amusing *music festivals* and his many cartoons portraying the comic aspects of music.



"The Cymbals" from *The Hoffnung Symphony Orchestra*

Gerard Hoffnung played in an orchestra in London for a number of years. Many of Hoffnung's cartoons feature humorous representations of orchestral musicians at work.

Hoffnung was born in Germany. He settled in Britain as a child. He was educated at Highgate School and Hornsey School of Art, London. For many years, Hoffnung played the bass tuba in a London orchestra.

Hofmann, Hans (1880-1966), a German-born American artist, became famous for his abstract painting. His work as an artist and teacher greatly influenced the development of abstract art in the United States, especially after World War II (1939-1945). Hofmann was familiar with the early modern art movements, such as cubism, expressionism, and fauvism. He used elements from them in his own varied works. Generally, his paintings are exceptionally active, with brilliant colours and swiftly moving lines, and sometimes very thick surfaces. Hofmann's advice to his students to be attentive to elements of "push and pull" in composition characterizes his work.

Hofmann was born in Weissenburg, near Nuremberg, Germany. He settled in the United States in 1930. In 1934, he opened an art school in New York City. His painting *The Golden Wall* appears in the **Painting** article. His drawing *Colour Intervals at Provincetown* is in the **Drawing** article.

Hofmannsthal, Hugo von (1874-1929), an Austrian poet and playwright, is best known for *librettos* (texts) for the operas of German composer Richard Strauss. Hofmannsthal and Strauss began a successful collaboration with *Elektra,* first staged in 1909. They continued with *Der Rosenkavalier* (1911), *Ariadne auf Naxos* (1912), *The Woman Without a Shadow* (1919), *The Egyptian Helen* (1928), and *Arabella,* produced in 1933 after Hofmannsthal died.

Hofmannsthal was born and educated in Vienna. As a young man, he created a literary sensation there with a series of symbolic verse dramas. His best-known play is *Everyman* (1911), an adaptation of an English medieval morality play. His poetry is filled with symbolism and is deeply melancholy.

See also **Strauss, Richard.**

Hog. See **Pig.**

Hogan, Ben (1912-   ), an American golfer, was one of the greatest players in the history of the sport. Hogan won more than 60 tournaments, including the United States Open four times, the Professional Golfers' Association (PGA) tournament twice, the U.S. Masters twice, and the British Open once.

In 1949, a bus struck the car Hogan was driving. The collision fractured his left collarbone, left ankle, pelvis, and a rib. Hogan barely survived the injuries. Doctors feared he might not be able to walk again, much less play golf. Yet, just 17 months after the accident, Hogan won the 1950 U.S. Open. He played the tournament with his legs wrapped in bandages.

Hogan was born in Dublin, Texas. His full name is William Benjamin Hogan. He became famous for his determination to perfect his swing through hours of practice. Hogan was one of the smallest golf champions, weighing only 61 kilograms.

See also **Golf** (picture; tables).

Hogan, Paul (1940-   ), an Australian comedian and actor, gained international attention when his film *Crocodile Dundee* was released in 1986. In Australia, the film set a new record when it took more than 27 million Australian dollars after its first release to 88 cinemas. That same year, it was shown in cinemas all around the world.

Hogan was born in Sydney. He worked as a rigger on the Sydney Harbour Bridge for 10 years. He made his first television appearance in a talent show called *New Faces* in 1972. In 1985 he won the Australian of the Year award.

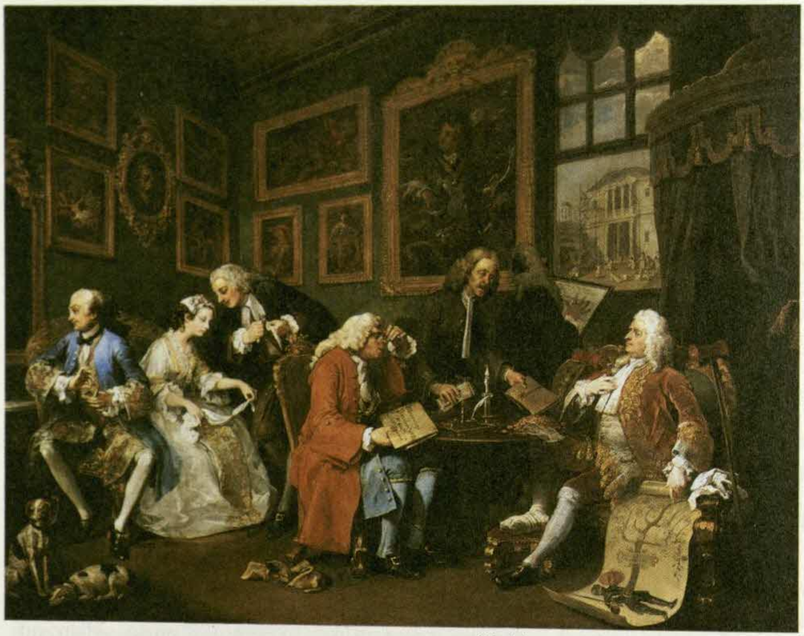
Hogarth, William (1697-1764), was the leading English satirical painter of the 1700's. He was also a noted engraver and art critic. Hogarth became best known for paintings and engravings that humorously commented on the manners and morals of his time.

Hogarth created several series of paintings that told a story through a number of related scenes. These series include the eight paintings that make up *A Rake's Progress* (early 1730's) and the six paintings in *Marriage à la Mode* (1743). Hogarth made engravings of both series. The sale of these engravings made him wealthy.

Hogarth was born in London. He was trained to be a silversmith but decided to devote himself to fine art. Hogarth carefully studied the masters of Flemish, French, and Italian painting, but he was also inspired by the life he observed around him.

Hogarth first gained success as a painter with a picture based on *The Beggar's Opera* (1728), a musical play about criminals and corrupt public officials in London. This painting launched him on a career as a painter of comic scenes of everyday life. Hogarth also painted many realistic, often unflattering, portraits that reflected the artist's strong sense of colour and his powers of observation.

Hogarth was a controversial and outspoken art critic whose opinions angered many of his fellow artists. He wrote one book, *The Analysis of Beauty* (1753), which



A Hogarth painting called *Signing the Marriage Contract* is part of a series of six paintings called *Marriage à la Mode.* The series provides a satirical commentary on upper-class marriage customs in England during Hogarth's time. The fathers of the bride and groom, seated on the right, arrange the bride's dowry with two lawyers. On the left, another lawyer explains financial details of the contract to the bride. The bored groom is on the far left.

Oil painting on canvas (1743); the National Gallery, London

combined practical advice on painting with his own theories of art.

See also **Fielding, Henry** (picture).

Hogben, Lancelot (1895-1975), a gifted English physiologist, also interested himself in language and communication and in making scientific subjects understandable to laypeople. His many books include *Nature and Nurture* and *Mathematics for the Million* (both 1936), *Science for the Citizen* (1938), *Essential World English* (1963), *The Mother Tongue* (1964), and *The Vocabulary of Science* (1970). Hogben was born in Southsea, Hampshire, England. He was educated at Cambridge University.

Hogg, Helen Sawyer (1905-), an American-born astronomer, became known for her research on *variable stars.* She discovered more than 250 of these stars, whose light varies in brightness. Hogg chiefly studied variable stars in *globular star clusters,* which are ball-like groups of stars in the Milky Way galaxy. Her work included measuring the *period* of many of these stars. A variable star's period is the time its light takes to change from bright to dim and back to bright. This information, in certain cases, helps astronomers determine the distance of the star from the earth.

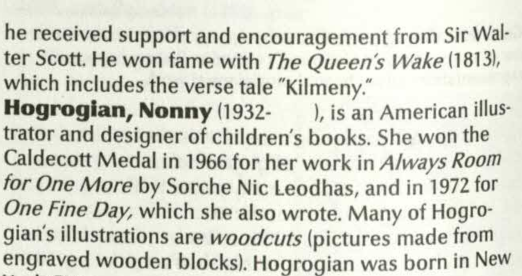
Helen Battles Sawyer was born in Lowell, Massachusetts. In 1930 she married Frank S. Hogg, a Canadian astronomer. She received a Ph.D. degree from Radcliffe College in 1931. Her major work, *Catalogue of Variable Stars in Globular Clusters,* was first published in 1939. In 1935, Hogg joined the University of Toronto. In 1957, Hogg became the first woman to serve as president of the Royal Astronomical Society of Canada.

Hogg, James (1770-1835), was a Scottish poet and novelist. He was known as the "Ettrick Shepherd" because he was born in the Ettrick Forest, Borders Region, and worked as a shepherd in his youth. His first book of verse was published in 1801, but had little success. Then he received support and encouragement from Sir Walter Scott. He won fame with *The Queen's Wake* (1813), which includes the verse tale "Kilmeny."

Hogrogian, Nonny (1932-), is an American illustrator and designer of children's books. She won the Caldecott Medal in 1966 for her work in *Always Room for One More* by Sorche Nic Leodhas, and in 1972 for *One Fine Day,* which she also wrote. Many of Hogrogian's illustrations are *woodcuts* (pictures made from engraved wooden blocks). Hogrogian was born in New York City.

Hogmanay is the word used to describe New Year's Eve celebrations in Scotland. On New Year's Eve, crowds wait outside the Tron Church in Edinburgh to sing and dance to the music of bagpipes as soon as midnight strikes. In some country districts, people light bonfires and hold torchlight parades.

Hogweed is a large plant of the cow parsley family. It grows in hedgerows and waste ground in Europe.



Giant hogweed can cause an irritating rash on contact with human skin. The plant originally grew in the Caucasus Mountains.

Hogweed grows up to 1.5 metres high and has broad, deeply cut leaves. The *umbels* (umbrella shaped flower heads) may be white, pink, or purple. The plant gets its name because it used to be a common plant fed to pigs.

The *giant hogweed* grows to over 3 metres high and has flower heads 1 metre across. This plant originally grew in the Caucasus Mountains in the Soviet Union. It was introduced to Europe as an ornamental plant, and now grows wild in many areas. It grows best in a cool, moist soil in full sun or partial shade. Giant hogweed causes a rash if it touches human skin.

Scientific classification. Hogweeds belong to the family Umbelliferae (Apiaceae). Hogweed is *Heracleum spondylium,* and giant hogweed is *H. mantegazzianum.*

Hohenstaufen was the name of a princely family of medieval Germany which held the imperial throne from 1138 to 1254. The family took its name from the ancestral castle built at Staufen in southern Germany during the 1000's.

Frederick of Hohenstaufen received the duchy of Swabia from Emperor Henry IV as a reward for loyal service. He married Henry's daughter Agnes. Frederick's son, also called Frederick, claimed the hereditary right to the crown. But in 1125 the German princes reaffirmed their right of free election.

In 1138, a member of the Hohenstaufen family secured the German throne as Conrad III. Frederick I (Barbarossa), Henry VI, and Frederick II were also Hohenstaufen rulers.

See also **Frederick II** (Holy Roman emperor); **Germany** (History); **Henry** (VI), Germany.

Hohenzollern is the name of the famous royal family that ruled Brandenburg, Prussia, and the German Empire. The name came from the family castle of Zollern in Swabia.

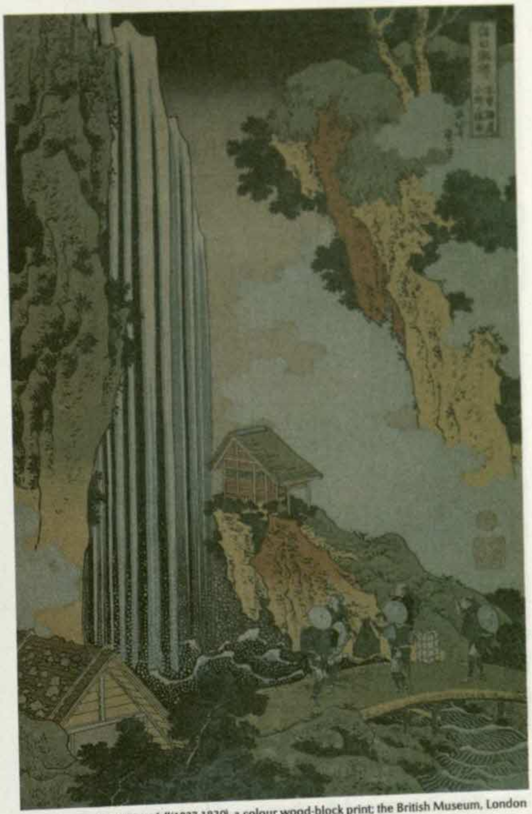
The Hohenzollerns started as counts. They became *electors* (rulers) of Brandenburg in 1417. In 1618, they began to add parts of Prussia to their holdings. Prussia was recognized as a kingdom in 1701 under Frederick I. After Germany was united in 1871, the Hohenzollerns were both kings of Prussia and German emperors. They established efficient governments and strong armies. The family lost its throne in World War I.

The best-known Hohenzollern rulers included Frederick William, the Great Elector; Frederick William I; Frederick II; and Wilhelm II. Wilhelm II was the German Kaiser during World War I.

See also **Franco-Prussian War; Frederick II** (of Prussia); **Frederick III** (of Prussia); **Frederick William; Germany** (History); **Wilhelm I; Wilhelm II.**

Hokkaido. See **Japan.**

Hokusai (1760-1849) was a Japanese painter and designer of woodcut prints. Hokusai created an enormous number of paintings and prints using many styles and subjects, but he is best known for his landscape prints. Hokusai ranks with Hiroshige as the most famous Japanese landscape artist of the 1800's. Hokusai created several series of prints from 1823 to 1835. One famous set of prints consists of scenes of Mount Fuji as seen from various points, both near and far.



Ono Waterfall (1827-1830), a colour wood-block print; the British Museum, London

A Hokusai print shows the artist's skill in portraying landscapes. Hokusai's decorative style emphasizes the bold use of line. He usually limited his colours to blue, brown, and green.

Katsushika Hokusai was born in Edo (now Tokyo). He studied under Katsukawa Shunshō, a leading Japanese artist. Hokusai had a long career, but he produced most of his important work after the age of 60. Although his works were popular, Hokusai spent much of his life in poverty. In the 1850's, after his death, some of his prints were displayed in the West. In the late 1800's, they influenced some Western artists, including James A. M. Whistler, Paul Gauguin, Vincent van Gogh, and Henri de Toulouse-Lautrec.

See also **Animal** (picture: People and animals).

Holbein, Hans, the Elder (1465?-1534?), was a painter who worked in southern Germany and the region of Alsace in what is now France. Holbein was born in Augsburg, Germany, and maintained a workshop in the city during the late 1490's and early 1500's. His two sons, Ambrosius and Hans the Younger, received their first training as painters there.

Holbein's paintings include altarpieces for churches and convents. His best works, however, were his drawings, particularly portraits of his two sons done in a technique called *silverpoint.*

Holbein, Hans, the Younger (1497?-1543), ranks among the world's greatest portrait painters. Holbein was born in Augsburg, Germany. He received his earliest training there from his father and uncles, but moved to Switzerland when he was about 18 years old. Holbein worked in Basel, where he painted the portraits of many important people, notably the Dutch scholar Desiderius Erasmus. During this time, Holbein also designed a series of woodcuts called *The Dance of Death* (1523-1526)

Kunsthistorisches Museum, Vienna

A portrait by Hans Holbein the Younger shows how the artist realistically captured the character of his subjects. Holbein painted this picture of an unknown young merchant in 1541.

and painted several important religious works, such as *The Dead Christ* (1521).

Holbein spent the winter of 1526-1527 in London as the house guest of Erasmus' friend Saint Thomas More. Holbein painted and drew portraits of the More family and their friends. He settled permanently in England in 1532 and soon became court painter to King Henry VIII. His duties included designing jewellery and painting portraits of the king and other members of the royal court and household. Many of these portraits have a flat, patterned appearance, perhaps to emphasize that they represent royalty.

For examples of Holbein's portraits, see **Clothing** (Puffs of fabric); **Edward (VI); Erasmus, Desiderius; Henry (VIII); More, Saint Thomas; Renaissance** (picture: Desiderius Erasmus).

Holberg, Ludvig (1684-1754), was Scandinavia's first important playwright. Holberg, who wrote in Danish, modelled his comedies on the works of the Roman playwright Plautus. Like Plautus, Holberg used typical comic characters such as a talkative barber, an amateur politician, and a bragging soldier. He relied heavily on mistaken identities to add excitement to his plots. Among Holberg's best-known comedies are *The Political Tinker* (1722), *Jeppe of the Hill* (1722), and *Erasmus Montanus* (1731). Holberg also wrote *Peder Paars* (1719-1720), a satirical poem; and *Niels Klim* (1741), a prose satirical account of an imaginary underground journey. His *History of the Danish Kingdoms* (1732-1735) was the first cultural history of Denmark written in the Danish language.

Holberg was born in Bergen, Norway. He was educated in Copenhagen. Later he taught at the University of Copenhagen.

Holborn. See **Camden.**

Holden, Sir Edward (1885-1947), an Australian motorcar manufacturer, was a member of the family after whom the first mass-produced Australian motorcar was named. Edward Wheewall Holden was born in Adelaide, South Australia. With his father, Henry Holden, Edward established a business for constructing motorcar bodies in 1917. In 1930, General Motors merged with the South Australian body-building company to form General Motors-Holden's. The first Holden motorcar came off the assembly line in 1948.

Holderness (pop. 49,900) is an English local government district on the coast of Humberside, administered from Skirlaugh, near Hull. The district includes the small inland town of Hedon and the seaside resorts of Hornsea and Withernsea. Important local industries include agriculture, chemicals manufacture, and tourism. Hornsea has a pottery industry making use of local boulder clay.

Holding company is any company which holds a majority or a large enough minority of the stock or voting power in another company to control its policies. The holding company may control the appointment of officers and may dictate business policies. Companies controlled by holding companies are called *subsidiary* companies.

Company A might buy a controlling interest in both Companies 1 and 2. Company B might similarly buy control of Companies 3 and 4. Companies A and B have become holding companies, and Companies 1, 2, 3, and 4 have become subsidiary companies. A third large company, C, might buy control of both Companies A and B. This process, called *pyramiding,* has created financial empires, especially in public utilities, banking, and manufacturing.

See also **Company; Antitrust laws.**

Holey dollar, a silver coin used in Australia in the 1800's, was a Spanish dollar with a *dump* (a small piece of silver) removed from its centre. Spanish dollars had been worth five shillings, but became scarce. The Australian government issued holey dollars at five shillings and dumps at one shilling and three pence. The coins circulated from 1814 until the 1830's.

Holford, Lord (1907-1975), an architect and town planner, is best known for his imaginative schemes for rebuilding Piccadilly Circus and the area around St. Paul's Cathedral in London. His architectural works include Farrer House at Eton, the Woolworth building in Oxford, the Market Square in Corby, and several university buildings. William Graham Holford was born in Johannesburg, South Africa. He became professor of town planning at London University in 1948.

Holiday is any day on which people lay aside their ordinary duties and cares. The word comes from the Anglo-Saxon *halig daeg,* or *holy day.* At first, holidays were given to honour some sacred event or holy person. Nowadays, people speak of holidays or vacations meaning a break from work, school, or everyday routine. For a discussion of religious holidays, see **Feasts and festivals.**

Some holidays are national holidays, when shops, schools, and businesses close. In Britain certain holidays are called Bank Holidays, because banks and government offices close on those days. Bank holidays include New Year's Day, Good Friday, Easter Monday, Christmas Day, and Boxing Day (the day after Christmas Day). There are also spring and summer bank holidays. In Scotland January 2 is a holiday. In Northern Ireland some people commemorate July 12 (anniversary of the Battle of the Boyne) as a holiday. In the Republic of Ireland, March 17 (St. Patrick's Day) is a holiday. The people of Scotland celebrate St. Andrew's Day (November 30), though it is not an official holiday. St. George's Day is not an official holiday in England.

New Year's Day (January 1) is a holiday in many countries. Hindus celebrate their New Year, Divali, in late autumn. The Chinese New Year (on the first new moon between January 21 and February 19) is celebrated by Chinese communities around the world. May Day (May 1), also called Labour Day, is a holiday in many countries. Christians, Muslims, Hindus and members of other religions observe special holidays. The most important day in the Jewish year is Yom Kippur, the Day of Atonement.

Some holidays commemorate important events in a nation's history. July 4 is Independence Day in the United States, and many other nations celebrate independence or other special days. They include Greece's Independence Day (March 25), Italy's Liberation Day (April 25), Canada's Dominion Day or Canada Day (July 1), India's Independence Day (August 15), Indonesia's Independence Day (August 17), Brazil's Independence Day (September 7), and Nigeria's National Day (October 1).

Anzac Day (April 25), the day the Anzac forces landed in Gallipoli in 1915 during World War I, is a national holiday in Australia and New Zealand. Australia's national holiday is Australia Day, which falls on a Monday, on or near January 26. The most important national holiday in New Zealand is Waitangi Day (February 6).

Americans celebrate the birthdays of George Washington (third Monday in February) and Martin Luther King (third Monday in January) as holidays, and in about 30 states Abraham Lincoln's birthday is a holiday in February. Another important American holiday is Thanksgiving Day (the fourth Thursday in November).

France has important public holidays on Bastille Day (July 14), and Joan of Arc's Day (second Sunday of May). In Japan, May 5 is a national holiday called Children's Day.

Related articles in *World Book.* See the *People* section of the country articles, and the articles on the months of the year. See also **Feasts and festivals** with its list of *Related articles.*

Other related articles include:

April Fools' Day
Arbor Day
Bastille Day
Boxing Day
Christmas
Easter
Fair
Father's Day
Halloween
Kwanzaa
Mardi Gras
May Day
Mother's Day
New Year's Day
Remembrance Day
Saint Patrick's Day
Thanksgiving Day
United Nations Day
V-E Day
V-J Day
Valentine's Day
Walpurgis Night

Holiday, Billie (1915-1959), won recognition as the most moving jazz singer of her day. She was admired for the uniquely bittersweet quality of her voice, and for phrasing that had much in common with the solos of the great improvising jazz musicians. Although Holiday was often described as a blues singer, she was principally an interpreter of popular songs.

Billie Holiday was born in Baltimore, Maryland, and raised in a black ghetto. She described the hardships of her childhood in *Lady Sings the Blues* (1956), her autobiography. She made her first recordings with Benny Goodman in 1933. During the 1940's, Holiday was strikingly beautiful and known for the gardenia she usually wore in her hair. After 1950, drug addiction increasingly affected her health and her career.

Billie Holiday

Holinshed's Chronicles is a book of English, Scottish, and Irish history and geography that was first published in 1578. The work is also known as the *Chronicles of England, Scotland, and Ireland.* William Shakespeare used it as source material for his tragedies *Macbeth* and *King Lear*, and for most of his historical plays. The *Chronicles* is named after Raphael Holinshed, an English historian. Reginald Wolfe, a London printer, began the book. Holinshed worked with him on it until Wolfe's death in 1573. Holinshed then completed the work with the assistance of several other writers. He probably died in 1580. A revised version was published in 1587. For political reasons, the government of Queen Elizabeth I ordered the removal of certain parts from each version.

See also **Shakespeare, William** (picture: A belief in witches).

Holistic medicine is an approach to health care based on the belief that many factors may affect a person's health. Such factors include genetics, nutrition, physical activity, stress, family relationships, medical care, and living and working conditions. However, any single factor might be the most important one for a particular person. The term *holistic medicine* comes from the Greek word *holos,* which means *whole.*

The emphasis of holistic medicine differs from that of orthodox medicine which focuses chiefly on the treatment of a specific disease. Holistic medicine emphasizes the prevention and treatment of disease. Some of its methods of diagnosis and treatment are not usually used in traditional medical practice. For example, doctors who practise holistic medicine use many treatments in addition to drugs and surgery. These methods include acupuncture, herbs, hypnosis, and relaxation therapies. Holistic doctors try to reduce their patients' use of drugs.

Many doctors, psychologists, and other health care professionals practise holistic medicine. Holistic practitioners stress the responsibility of the patient in achieving and maintaining the best possible health. They help patients establish good eating and exercise habits. They may also teach patients various methods of medical self-care. For example, a patient might learn to control a normally involuntary body process, such as the rate of the heartbeat, by means of relaxation techniques, meditation, or *biofeedback* (see **Biofeedback**).

The idea of a holistic approach to health is as old as medicine itself. Good medical practice has always included elements of holistic medicine. After the early 1900's, holistic medicine gained increasing popularity in many industrialized countries. Its popularity grew because many people began to realize that the most common noninfectious diseases, including cancer and heart disease, were related to specific life styles and such personal habits as smoking and diet.

Holland. See Netherlands.

Holland, John Philip (1841-1914), an Irish-American inventor, was mainly responsible for the development of the submarine. His vessel, the *Holland,* built in 1898, proved that the submarine was practical. It provided the model for later submarines.

Holland was born in County Clare, Ireland. He began work on the idea of a submarine while teaching in schools in Ireland from 1858 to 1872. By 1870, he had completed the first plans for his invention. In 1873, Holland moved to the United States. He settled in Paterson, New Jersey, and taught there. He submitted his submarine plans to the U.S. Navy in 1875, but they were rejected. But the Fenian Society, a group of Irish patriots in the United States who hoped to destroy England's naval power, became interested. They supported Holland's experiments and gave him money to build two submarines.

Holland's first boat was tested with mixed results in the Passaic River in 1878. His second boat, the *Fenian Ram,* was launched in 1881. Its success established many basic features of submarines.

In 1888, the U.S. Navy asked Holland to submit submarine plans. Seven years later, it awarded him a contract to build a ship. But this vessel failed, largely because the Navy forced Holland to drop many of his ideas. In order to prove that his ideas were correct, Holland privately built the *Holland* and launched it successfully in 1898. In 1900, the Navy bought the *Holland* and asked the inventor to build several more ships like it. Holland's firm, the Electric Boat Company (now the Electric Boat Division of General Dynamics Corporation), has continued to build most U.S. Navy submarines. It has also built many submarines for other countries.

Holland resigned from the Electric Boat Company in 1904 and attempted to establish a new firm. However, legal complications blocked the undertaking, and he died in obscurity.

See also **Submarine** (Early submarines).

Holly is the common name for a group of shrubs and small trees. The *English holly* is an evergreen tree. It has glossy green leaves and red berries that are used to make attractive Christmas decorations. In the past, holly was used in houses and churches at Christmas time, and was called *holy tree.* The word *holly* may have come from this name.

There are about 300 species of hollies. They grow in many temperate and tropical regions of the world.

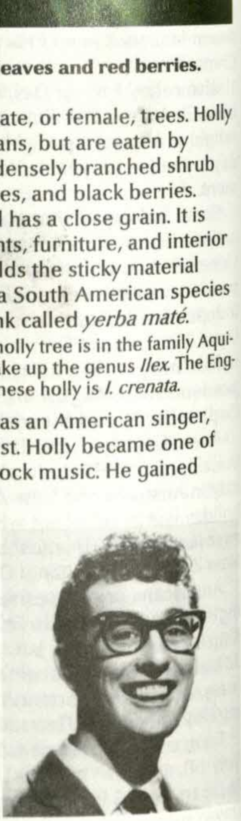
Holly is a favourite ornamental tree in Great Britain. Sometimes it is planted in hedges. The white flowers of the holly bloom in May, the same month as those of another hedge plant, the hawthorn. The red fruits are not real berries, but *drupes,* which are fruits with stones. They appear only on the pistillate, or female, trees. Holly berries are poisonous to humans, but are eaten by birds. The *Japanese holly* is a densely branched shrub with smooth, oval shaped leaves, and black berries.

The holly tree has shiny green leaves and red berries.

Holly wood is very hard and has a close grain. It is valuable for musical instruments, furniture, and interior decoration. The inner bark yields the sticky material called *birdlime.* The leaves of a South American species are used to make a tealike drink called *yerba maté.*

Scientific classification. The holly tree is in the family Aquifoliaceae. The different species make up the genus *Ilex.* The English holly is *I. aquifolium.* The Japanese holly is *I. crenata.*

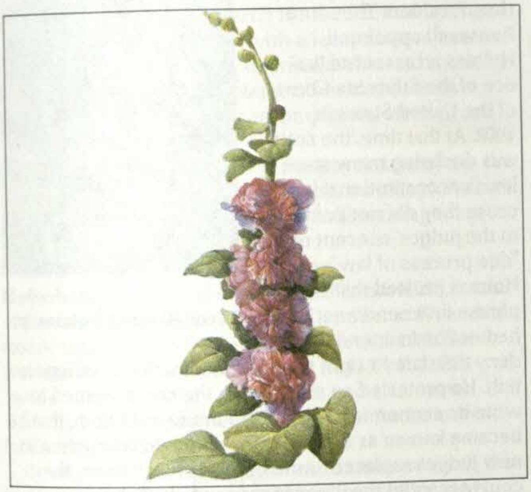
Holly, Buddy (1936-1959), was an American singer, composer, and electric guitarist. Holly became one of the first major performers of rock music. He gained fame in 1957 when his band, the Crickets, recorded "That'll Be the Day." That same year, he recorded his first solo hit, "Peggy Sue." He was co-composer of both songs. Holly and his band developed an energetic style that combined elements of country music with a strong background rhythm. This style influenced many American and British rock performers.



Buddy Holly

Holly was born in Lubbock, Texas. His full name was Charles Hardin Holley. He began playing the piano when he was 11 years old but soon turned to playing the guitar. He performed as a country singer during the early 1950's. Holly died in a plane crash near Mason City, Iowa, at the age of 22.

Hollyhock is a tall, hardy plant grown for its large spikes of colourful flowers. It is native to Asia, but is grown widely in Europe and the United States. Its large, fuzzy, heart-shaped leaves start as low rosettes. Tall, heavy stems rise to bear the flower spikes. Hollyhocks bloom from July to early September. They are used as background borders or along fences. The flowers are



A hollyhock has tall spires of colourful blossoms and large, heart-shaped leaves. A double hollyhock, *above,* has an extra clump of petals inside the wider outer petals.

round and open wide. Their colours range from white, through yellow, pink and red, to purple.

Most hollyhocks are perennials that usually bloom the second year. They can be started outdoors. But some gardeners sow hollyhocks in a seed box in July and then transplant them to their garden the following spring. Annual hollyhocks bloom the same year that the seeds are planted.

Hollyhocks thrive in well-drained soil and full sunlight. When the flowers fade, the plant stalks lose their attractiveness, and can be cut down. A few stalks can be left standing if seed is desired. A fungal disease called *rust* sometimes attacks hollyhocks.

Scientific classification. Hollyhock belongs to the mallow family, Malvaceae. It is *Alcea rosea.*

See also **Flower** (picture: Garden biennials); **Mallow.**

Hollywood, California, U.S.A., is generally considered the film capital of the world. It is not a city, but a district of Los Angeles. About 210,000 people live in the area.

The Hollywood Bowl, a large open-air theatre, is famous for its symphony programmes, concerts, and Easter services. Restaurants, gift shops, theatrical agencies, and nightclubs line a section of Hollywood's Sunset Boulevard called "The Strip." The popular Walk of Fame consists of more than 1,800 bronze stars set in the pavements along Hollywood Boulevard and Vine Street. Each star has the name of a different Hollywood celebrity. The huge "Hollywood" sign, a landmark built in the hills above the district in 1922, was restored in 1978. Each letter of the sign is 14 metres tall.

One adobe hut stood on the site of Hollywood in 1853. By 1870, the area was a farming region. It was incorporated as Hollywood in 1903, but voted to join the city of Los Angeles in 1910 in order to gain access to the Los Angeles water supply.

The Nestor Company built the first film studio in Hollywood in 1911. Hollywood became a centre of the film industry because it has a mild, dry climate, and because it lies in an area with a vast variety of natural scenery. Within 300 kilometres, almost every kind of scenic background is available to filmmakers. The production of sound films began in Hollywood in the late 1920's and resulted in the building of huge sound stages, many now used for making television films.

See also **Film industry.**

Holmes, Oliver Wendell (1809-1894), was an American writer who won fame for his essays and poems. He was also a doctor and taught at the Harvard Medical School during the years of his greatest literary success. Holmes was known for his keen mind and charming, witty literary style. His enthusiasm and humour made him popular as a teacher and public speaker. His son, Oliver Wendell Holmes, Jr., became a famous associate justice of the Supreme Court of the United States.

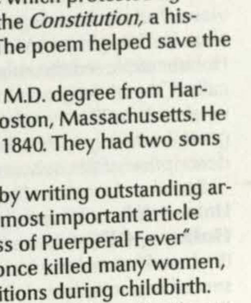
His life. Holmes was born in Cambridge, Massachusetts, where his father was a prominent Congregationalist minister. As a youth, Holmes rebelled against the strict religious beliefs of his father. Holmes later supported liberal religious opinions in many of his speeches and writings.

In 1829, Holmes graduated from Harvard College and entered law school. But law bored him and, in 1830, he began to study medicine. He studied at the Harvard Medical School and with private doctors in Boston and Paris. While a student, Holmes wrote many poems. They included "Old Ironsides" (1830), which protested against the U.S. Navy's plan to destroy the *Constitution,* a historic but unseaworthy frigate. The poem helped save the ship. See **Constitution** (ship).

In 1836, Holmes received an M.D. degree from Harvard and became a doctor in Boston, Massachusetts. He married Amelia Lee Jackson in 1840. They had two sons and a daughter.

Holmes gained recognition by writing outstanding articles on medical subjects. His most important article was called "The Contagiousness of Puerperal Fever" (1843). Puerperal fever, which once killed many women, resulted from unsanitary conditions during childbirth. Medical workers of Holmes's time paid little attention to cleanliness. Holmes showed that doctors could help prevent the disease simply by washing their hands and putting on clean clothes before delivering babies. His publication helped save many lives. Holmes later considered it his greatest achievement.

In 1847, Holmes was appointed dean of the Harvard Medical School and professor of anatomy and physiology. He served as dean until 1853 and taught until 1882. Holmes was generally assigned the last period of the morning for his lectures, because his enthusiasm and humour kept tired, hungry students interested in their work.



Oliver Wendell Holmes

Holmes also became popular as a public speaker. Through the years, he wrote and recited amusing poems for many special events and presented lively lectures on literature. His warmth and sense of fun won him many friends, including several leading authors.

In 1857, Holmes helped James Russell Lowell and other writers launch a new magazine. Holmes named it the *Atlantic Monthly* and joined the staff as a columnist. His wise, witty column made both Holmes and the *Atlantic Monthly* famous. Holmes continued to publish essays, fiction, and poetry until he was in his 80's.

His writings. Most of Holmes's poems are more like popular verse than serious poetry. But many are notable for their accurate descriptions of nature or their understanding of human character. His best-known poems, in addition to "Old Ironsides," include "The Last Leaf" (1831), "The Chambered Nautilus" (1858), "Contentment" (1858), and "The Deacon's Masterpiece: or, The Wonderful 'One-Hoss Shay' " (1858).

Holmes's best-known book, *The Autocrat of the Breakfast-Table* (1858), consists of his first 12 essays for the *Atlantic Monthly.* Each essay supposedly tells about a lively, witty conversation that takes place at the breakfast table of a boarding house. The talk actually expresses the author's own observations and opinions on many subjects, including human nature, manners, religion, and science.

Holmes also wrote three novels—*Elsie Venner* (1861); *The Guardian Angel* (1867); and *A Mortal Antipathy* (1885). All three promote Holmes's liberal religious views, but none ranks as outstanding fiction. In "Mechanism in Thought and Morals," a lecture given in 1870, Holmes explored the subconscious mind, which he called "the underground workshop of thought." He wrote this brilliant work more than 20 years before the great Austrian psychiatrist Sigmund Freud published his description of the subconscious.

See also **American literature** (The Boston Brahmins); **Holmes, Oliver Wendell, Jr.**

Holmes, Oliver Wendell, Jr. (1841-1935), was one of the best-known American judges of the 1900's. He served as a member of the Supreme Court of the United States for nearly 30 years. During that period, he made great contributions to the changing concepts of law. His keen intellect, humour, and ability to express himself helped to direct American thought.

Early life. Holmes was born on March 8, 1841, in Boston, and was named after his father, the writer and doctor. He enlisted in the Union Army, fought through most of the American Civil War, and was wounded three times. It is said that once when Holmes saw a tall civilian leaving himself open to enemy fire, he yelled, "Get down, you fool." Later, he learned the civilian was President Lincoln. Holmes resigned as a lieutenant colonel after three years.

As a young man, Holmes was a close friend of William James, and thought of becoming a philosopher himself. Law, he said, was "a rag bag of details." Yet, at the end of his war service, he entered Harvard Law School at the urging of his father. Early in his career, he became coeditor of the *American Law Review* and wrote his great work, *The Common Law* (1881). In 1882, he became a professor of law at Harvard and was appointed to the Supreme Judicial Court of Massachusetts. He became chief justice of Massachusetts in 1899.

Oliver Wendell Holmes, Jr.

Supreme Court justice. President Theodore Roosevelt appointed Holmes an associate justice of the Supreme Court of the United States in 1902. At that time, the court was declaring many state laws unconstitutional because they did not conform to the judges' concept of "due process of law." Holmes insisted that this phrase in Amendment 14 had not been intended to deny the states a right to experiment with social legislation. He protested so often when the court seemed to write its economic theories into the Constitution, that he became known as the *Great Dissenter.* In later years, as new judges replaced some of the conservatives, the court accepted the ideas in many of his dissents.

Much of the legislation Holmes voted to save was designed to improve social conditions. But he was not primarily a reformer. He believed in bigness, and often expressed admiration for industrial tycoons. His dissents did not indicate that he approved the laws that the majority was striking down. Rather, he dissented because he believed that judges have no right to interfere with legislative policy unless it violates the Constitution.

"The life of the law," Holmes wrote, "has not been logic; it has been experience." By insisting that the court look at facts in a changing society, instead of clinging to worn-out slogans and formulas, Holmes exercised a deep influence on the law. He influenced judges to keep from allowing their personal opinions to affect their decisions. This doctrine, known as *judicial restraint,* has since come to dominate American judicial thinking.

Holmes's sharp phrases as well as his philosophy caught the public imagination. People understood him because he was "down to earth." In some respects, he is more famous as a philosopher than as a judge.

With all his brilliance, Holmes was a man of many contradictions. His inclination to let the states experiment led to some opinions now regarded as illiberal. His major contribution was in convincing people that the law should develop along with the society it serves.

Holmes is one of the few judges of his time who could truthfully say that he felt "the secret isolated joy of the thinker, who knows that, a hundred years after he is dead and forgotten, men who never heard of him will be moving to the measure of his thought."

Holmes, Sherlock, is the most famous detective in fiction. He was created by Sir Arthur Conan Doyle, an English author, and appears in 56 short stories and 4 novels.

In all the stories, Holmes displays an ability to solve baffling crimes through clever observation and deduction. He draws amazing conclusions from minute details. His remarkable powers of concentration and broad knowledge of science also help him solve many mysteries.

Holmes is assisted by his friend Dr. John Watson, who records most of Holmes's cases. The two men live in London at 221B Baker Street. Doyle described their quarters so realistically that many readers have visited Baker Street in order to search for the fictional address.

Holmes is a tall, thin man with a lean, narrow face. He is often pictured wearing a deerstalker hat and smoking a pipe. Holmes has many interests besides detective work. For example, he is an accomplished violinist and an expert on beekeeping.

Doyle introduced Holmes in the novel *A Study in Scarlet* (1887). He modelled him partly on Joseph Bell, a Scottish doctor known for making brilliant diagnoses through observation.

See also **Doyle, Sir Arthur Conan.**

Holmium, a chemical element with symbol Ho, is one of the rare-earth metals. Its atomic number is 67, and its atomic weight is 164.930. The Swiss scientist J. L. Soret first identified the element in 1878. In 1879, P. T. Cleve of Sweden independently discovered, and also named, the element. The name comes from *Holmia,* the Latin word for Stockholm, Sweden.

Holmium occurs in monazite and similar minerals that bear rare earths. It is best separated from other rare earths by ion exchange processes or by solvent extraction. The metal has a silver colour. It melts at 1474° C, and boils at 2700° C. Its density is 8.78 grams per cubic centimetre at 25° C. The cream-coloured oxide Ho_2O_3 is soluble in mineral acid.

See also **Element, Chemical; Rare earth.**

Holocaust was the mass murder of European Jews by the Nazis during World War II. The Nazi dictator Adolf Hitler planned to wipe out the entire Jewish population as part of his plan to conquer the world. By the end of the war in 1945, the Nazis had killed about 6 million Jewish men, women, and children—over two-thirds of the Jews in Europe. They also killed many members of other ethnic groups, especially Gypsies, Poles, and Slavs. No one knows the exact number of civilians murdered by the Nazis, but historians estimate that at least 11 million people were killed, including the Jews. The word *holocaust* means *widespread destruction.* For detailed information on Hitler's rise to power and his hatred of Jews, see **Hitler, Adolf.**

During the Holocaust, millions of Jews were forced to leave their homes and were imprisoned in concentration camps.

The Nazi persecution of the Jews began after Hitler came to power in 1933. As Germany prepared for war, the government imposed many laws and restrictions that deprived Jews of their rights and possessions. For example, the Nazis prohibited Jews from attending universities and other schools, and seized their property and businesses.

Some historians trace the start of the Holocaust to the night of Nov. 9, 1938. Beginning that night and continuing for about 48 hours, Nazi Party members killed dozens of Jews and sent between 20,000 and 30,000 others to *concentration camps* (camps for political prisoners). The Nazis also burned or demolished more than 200 synagogues and destroyed about 7,500 Jewish-owned businesses throughout Germany. The night has become known as *Kristallnacht,* a German word meaning *the night of broken glass.*

In 1939, the Germans invaded Poland and gained control over that country's approximately 3 million Jews. The next year, the Nazis conquered Belgium, Denmark, France, Norway, and the Netherlands, and hundreds of thousands more Jews fell into their hands. Jews were forced to live in special areas called *ghettos* and to work as slave labourers.

The Nazis invaded the Soviet Union in 1941 and began a campaign of mass murder against all of the Jews of Europe. Special Nazi units followed the rapid advance of the German army and killed more than a million Jews in conquered areas.

Eventually, millions of Jews were imprisoned in concentration camps. These camps included gas chambers in which large numbers of victims were killed with poison gas and factories in which prisoners were worked to death. The captives lived under horrible conditions, and many died of starvation and disease. Doctors performed cruel experiments on some prisoners. Those unable to work – the aged, the sick, many women, and most children – were gassed.

During the Holocaust, the Germans kept their actions as secret as possible and deceived the victims in many ways to prevent resistance. After word of the slaughter leaked out, Jews fought back in Warsaw, Poland, and in other cities though they were outnumbered and mostly unarmed. Jews also staged uprisings in several concentration camps.

Related articles in ***World Book*** include:

Anti-Semitism
Auschwitz
Babi Yar
Belsen
Buchenwald
Concentration camp
Dachau
Jews (The Holocaust)
Wiesel, Elie

Holography is a method of making three-dimensional images on a photographic plate or film. The depth in the scene makes its objects seem real. These types of images appear on some credit cards to prevent counterfeiting.

There are two basic steps in holography: (1) making a pattern called a *hologram* and (2) producing the three-dimensional image. In the first step, a special device splits a beam of light from a laser into two beams. One beam illuminates a scene and reflects its image on the film. The other beam, called a *reference beam,* shines

Some holograms, such as that of a bird on this credit card, are three-dimensional images used to prevent counterfeiting.

directly on the film. The reflected image and the reference beam interfere with each other, forming a complex pattern on the film. The developed film is the hologram. In the second step, light that shines from the same direction as the reference beam illuminates the hologram. The hologram changes this light to reconstruct the light patterns from the original scene, making a three-dimensional image. In many cases, the light source is a laser.

Holography has a number of research and analytic applications. For example, it is used to check for flaws in aircraft wings, tyres, lenses, and other objects. Holography is also used to measure velocities of moving particles and to produce three-dimensional images of objects viewed with a microscope.

Holography was invented in 1947 by Dennis Gabor, a Hungarian-born engineer. He received the 1971 Nobel Prize in physics for his invention.

Holst, Gustav (1874-1934), was an English composer and teacher. Holst composed many of his works for vocal soloists and chorus. These compositions show his sensitivity to the human voice and to language as well as his love for the English folk song tradition. However, Holst's best-known work is the orchestral suite *The Planets* (1914-1916). This suite consists of seven parts, each interpreting the astrological nature of a planet.

Holst composed two suites for military band (1909, 1911) based on English folk songs. *The Hymn of Jesus* (1917) is a work for orchestra and chorus based on the Apocrypha of the New Testament. The poetry of John Keats inspired Holst's *First Choral Symphony* (1925) for soprano, chorus, and orchestra. Holst also wrote a number of works that reflect his interest in Hindu literature. In 1908, for example, Holst composed nine hymns for vocal soloist and piano based on the ancient Hindu sacred book the *Rig-Veda*.

Holst was born in Cheltenham, Gloucestershire. In 1905 he became director of music at St. Paul's Girls' School, Hammersmith, London. His *St. Paul's Suite* (1913) for strings is dedicated to the school orchestra. From 1907 until his death, he served as musical director at Morley College, London. Holst also taught at the Royal College of Music from 1919 until his death.

Holt, Harold (1908-1967), was prime minister of Australia for less than two years. He succeeded Sir Robert Menzies on Jan. 25, 1966, and continued the coalition government of Liberal and Country parties. But he disappeared while swimming off the Mornington Peninsula in December 1967.

Holt was treasurer of Australia from 1958 to 1966. He held many important economic positions for Australia, including membership on the board of governors of the International Bank for Reconstruction and Development, the International Monetary Fund, and the International Finance Corporation.

Harold Holt

Holt was born in Sydney and educated at Wesley College, in Melbourne. In 1935, he was elected to the House of Representatives.

During World War II, he helped establish the Department of Labour and National Service. In 1949, Holt became minister for immigration. He was appointed a privy councillor in 1953 and became leader of the House of Representatives in 1956.

Holtermann, Bernard Otto (1838-1885), was one of the discoverers of the largest nugget of gold found anywhere in the world. He made the discovery at Hill End, New South Wales, Australia, in 1872. Later that year, Holtermann commissioned Beaufroy Merlin and, later, Charles Bayliss to produce photographs of the goldfields to attract migrants to them. These pictures on glass negatives have provided a record of life on the goldfields. Holtermann was born in Hamburg, Germany. He arrived in Australia in 1858.

Holy Alliance was an agreement signed in Paris in September 1815, after the fall of Napoleon. Czar Alexander I of Russia originated the Alliance. The first two signatories were Francis I, Emperor of Austria, and King Frederick William III of Prussia. All the other rulers in Europe except the pope, the king of Great Britain, and the sultan of Turkey, also signed it.

Supposedly, the purpose of the Alliance was to unite the monarchs of Europe in a holy brotherhood to advance Christian principles. The agreement said that, in accordance with the teachings of Christ, the principles of charity, justice, and peace should be the basis of each ruler's international relations.

The agreement contained many high-sounding phrases, but had no practical effect. People often confuse the Holy Alliance with the Quadruple Alliance, which four nations—Austria, Prussia, Russia, and Great Britain—organized in 1815. The purpose of the Quadruple Alliance was to preserve peace in Europe. But soon the Austrian, Russian, and Prussian rulers became more interested in making Europe safe for autocracy. After Great Britain withdrew from the Alliance, the autocratic rulers put down the democratic uprisings of 1820.

See also **Alexander I** (czar); **Francis II** (Holy Roman emperor).

Holy Bible. See **Bible.**

Holy Communion. See **Communion.**

Holy Eucharist. See **Communion.**

Holy Ghost. See **Trinity.**

Holy Grail, in medieval legend, was the cup that Jesus Christ used at the Last Supper. According to some legends, the Grail was a dish or a stone.

The Holy Grail inspired some of the finest poetry of the Middle Ages. European poets established the basic parts of the Holy Grail story between about 1180 and 1240. These poets may have adapted the legend from a tale told much earlier by pagan Celtic people. The Celtic story described a magic cup or dish that provided food and drink for anyone who used it. Chrétien de Troyes, a French poet, wrote an unfinished poem about the Grail that later writers completed. Chrétien's poem became the best known of the Grail stories. Another poet, Wolfram von Eschenbach of Germany, wrote an important account of the legend that he based, at least partly, on Chrétien's work. The several versions of the Grail story written during the Middle Ages differ from one another on important points as well as in small details. But each version of the story describes a search for the Holy Grail by King Arthur's Knights of the Round Table.

Early history of the Grail. The Grail story begins with Joseph of Arimathea, a follower of Christ. Joseph used the cup to capture blood flowing from the wounds of Jesus as He hung from the cross. Later, the Romans imprisoned Joseph because he had been a follower of Jesus. While Joseph was in prison, the Grail mysteriously appeared to him. According to one version of the legend, the Grail fed Joseph in his cell for 42 years. After being freed, Joseph led a group of Christians who carried the Grail throughout the Holy Land. They used it to hold the wine during the Communion service.

Joseph later took the Grail to Britain, where he built a castle called Corbenic. He kept the Grail in the castle. Joseph and his descendants served as rulers of Corbenic and guardians of the Grail. The legend tells how Pelles, one of the castle rulers, suffered a wound that did not heal. The wound made Pelles unable to father children. Also, as long as the wound remained unhealed, no vegetation could grow in the land around the castle. The countryside became a wasteland.

The search for the Grail. Much of the Grail legend describes the search for the cup by King Arthur's Knights of the Round Table. On the feast of Pentecost, the knights gathered in a hall in Arthur's castle. Suddenly, in a brief vision, they saw the Grail suspended in the air. About 150 knights decided to search throughout Britain for the Grail.

The knights underwent many dangerous adventures during their search. Their actions during these adventures revealed that only three knights—Bors, Galahad, and Perceval—were morally perfect and therefore fit to complete the quest. After searching for years, the three knights, with nine men from other lands, entered Castle Corbenic. There they saw a vision in which Joseph of Arimathea appeared as a priest. Angels brought in the Grail and the bloody spear that had pierced Christ's side during the Crucifixion. A child appeared above the Grail and changed into bread. Then Christ emerged from the cup and gave Communion to the men. The vision was meant to prove that, in the Mass, the bread and wine are changed into the body and blood of Christ. This transformation became known as the miracle of the Grail.

Galahad healed Pelles, the wounded lord of the castle, with blood from the holy spear. As soon as the wound had healed, the land around the castle again became fertile. After leaving the castle, the three knights sailed on a ship which, they discovered, carried the Grail. Guided by supernatural forces, the ship took the knights and the Grail to the distant city of Sarras. There, after Galahad died, Bors and Perceval saw the Grail rise into heaven. According to the legend, no one has seen the Holy Grail since that time.

Later versions of the legend. Through the centuries, the legend of the Grail has inspired many writers and composers. For example, the English poet Alfred, Lord Tennyson wrote the long poem "The Holy Grail" as part of his *Idylls of the King.* The German composer Richard Wagner based his opera *Parsifal* on parts of the Grail legend.

See also **Chrétien de Troyes; Galahad, Sir; Wolfram von Eschenbach.**

Holy Island is the name given to a number of small islands in Britain and Ireland. The largest is Holy Island, or Lindisfarne, off the coast of Northumberland. There is a Holy Island at the mouth of Lamlash Bay, on Arran Island, in the Firth of Clyde; one in Lough Derg, in County Clare; and one in the Lakes of Killarney, in County Kerry.

Holy Land. See **Palestine.**

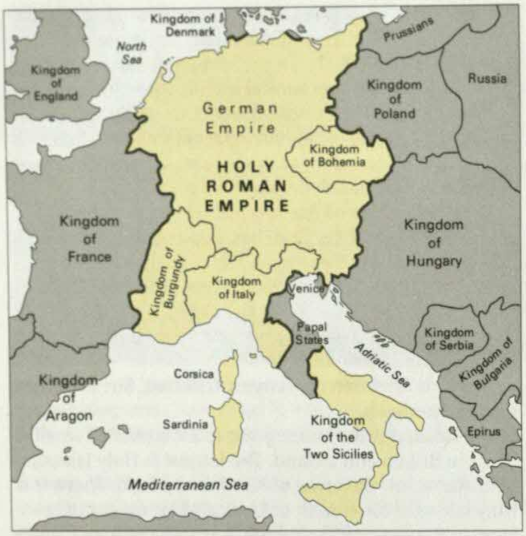
Holy Roman Empire was a German-based empire in western and central Europe that began in A.D. 962 and lasted until 1806. It was associated with the Roman Catholic Church but often suffered because of disputes between the Holy Roman emperors and the popes. The powerful Habsburg (also spelled Hapsburg) family ruled the empire for nearly 400 years.

Some scholars trace the origins of the Holy Roman Empire to an empire founded by the great ruler Charlemagne. Charlemagne's empire included most of what is now France, Germany, and Italy. In A.D. 800, Pope Leo III crowned Charlemagne emperor of the Romans. But the empire fell apart after Charlemagne died in 814. In the mid-900's, King Otto I of Germany gained control of most of northern and central Italy. In 962, Otto had Pope John XII crown him emperor of what became known during the 1200's as the Holy Roman Empire.

Problems of the empire. From the start, the empire faced serious problems. The emperor's authority was often challenged by powerful German nobles and unfriendly popes. The emperor's difficulties were made worse because he was chosen by election. Until the mid-1400's, strong nobles often disputed the election results, and these challenges sometimes led to civil war. Before 1500, the great size of the empire also made it difficult for the emperors to rule it effectively.

Problems with the popes began in the mid-1000's, when Holy Roman Emperor Henry IV and Pope Gregory VII each tried to establish authority over the other. Popes and emperors continued to fight for authority until 1250, when Pope Innocent IV and the Italian city-states gained almost complete independence from the empire.

The German nobles gained power during the struggle between the emperors and the popes. They were particularly powerful during the period from 1250 to 1273. In this period, called the *Interregnum,* there was no emperor at all. After elections for emperor resumed, the nobles chose an almost continuous succession of weak rulers for about 150 years.



The Holy Roman Empire in 1250 extended from the North Sea to the Mediterranean Sea. The Kingdom of the Two Sicilies, a personal possession of the emperor, was geographically separated from the empire by the Papal States.

The House of Habsburg. Albert II of the Habsburg family became Holy Roman emperor in 1438. The Habsburgs ruled from then to 1740 and again from 1745 to 1806. Many institutions of the empire took their final shape during the early years of the Habsburg period. They included a legislative body, courts, and a military system.

In the first half of the 1500's, the empire was headed by Charles V, the most powerful European ruler since Charlemagne. But Charles V eventually lost much of his power, in part because of the Protestant Reformation, which split Germany into rival Protestant and Roman Catholic groups. Habsburg power continued to decline as a result of losses in the Thirty Years' War (1618-1648) and the rise of the powerful German state of Prussia in the 1700's. Defeat by French armies during and after the French Revolution (1789-1799) further weakened Habsburg power. In 1806, after France defeated the Habsburgs, Emperor Francis II declared the end of the Holy Roman Empire.

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Habsburg, House of
Henry (of Germany)
Maximilian I
Otto (I, the Great)
Otto (II)
Sigismund
Thirty Years' War

Holy Scriptures. See **Bible** (introduction).
Holy Spirit. See **Trinity.**
Holy Thursday. See **Holy Week; Maundy Thursday.**
Holy Wars. See **Crusades.**

Holy Week is the period between Palm Sunday and Easter when Christians remember the final events in the life of Jesus. During this week, churches usually hold special services of worship and meditation.

Palm Sunday, the first day of Holy Week, commemorates Jesus' triumphal entry into Jerusalem, when the people spread palms and garments before Him. Christians in many traditions observe the day with a procession with palm leaves. On Thursday, called Maundy Thursday or Holy Thursday, services focus on the Last Supper of Jesus. Worship may include a foot-washing ceremony, in keeping with Jesus' command to His disciples that they wash each other's feet as He had washed theirs. In Good Friday services, Christians remember the day of Jesus' Crucifixion. On Holy Saturday, many churches hold the *vigil* (watch) of Easter, when worshippers recall Jesus' burial and await His Resurrection. The vigil marks the beginning of the Easter celebration and often includes a service of light, Holy Baptism, and Holy Communion.

The observances of Holy Week took their present form in the late 300's. Early Christians linked the final events of Jesus' life with the days on which these events were thought to have occurred. Christians related these events with the places in and around Jerusalem where tradition held they took place. For the many pilgrims who visited Jerusalem, worship services were conducted at the churches and shrines that tradition associated with Jesus' last days. As a result, the observances in Jerusalem produced for the entire church a week of special solemnity and services to commemorate the suffering and death of Jesus.

See also **Easter; Good Friday; Lent; Maundy Thursday; Palm Sunday.**

Holyoake, Sir Keith Jacka. See **New Zealand** (New Zealand today).

Holyroodhouse, Palace of, is a historic house in Edinburgh, Scotland. It is used by members of the royal family on visits to Scotland. It is the official residence for two weeks in the year of the Lord High Commissioner of the Church of Scotland.

David I chartered an Augustinian abbey at Holyrood in 1128 and granted it the right to rule a burgh. The

The palace of Holyroodhouse is used by the British royal family when visiting Edinburgh in Scotland.

abbey became rich and powerful. Construction of a palace at Holyrood began in 1501. Sir William Bruce built the present palace in the 1670's.

Homage, during the Middle Ages, was a feudal ceremony by which one man became the *vassal* or follower of a lord. The ceremony set up a personal and honourable tie between the vassal and the lord, who promised faithfulness to each other. The knight who was to become a vassal knelt before the lord, placed his hands between those of the lord, and acknowledged himself to be the lord's man. The lord then recognized him as a vassal, raised him to his feet, and kissed him. After performing homage, the vassal usually took an oath of fealty, swearing on the Bible or on holy relics to keep the faith he had pledged.

See also **Feudalism** (The principles of feudalism).

Home, Lord (1903-), was prime minister of Great Britain from October 1963 to October 1964. A member of the Conservative Party, he succeeded Harold Macmillan. He was succeeded by Labour Party leader Harold Wilson. Home served as foreign secretary from 1960 to 1963 and from 1970 to 1974.

Home served as a Conservative member of the House of Commons from 1931 to 1945. In 1945, he became joint parliamentary undersecretary of state for foreign affairs. After his father's death in 1951, Home became the 14th Earl of Home. He gave up his seat in the House of Commons and, as a member of the nobility, took his place in the House of Lords. He became secretary of state for Commonwealth relations in 1955 and leader of the House of Lords in 1957.

Lord Home

After Home was named prime minister, some members of the Conservative Party protested at his being selected. Traditionally, the prime minister must be a member of the House of Commons, and Home was no longer a member. The protesters were also upset because party leaders had disregarded other members' wishes by choosing Home. But after Home became prime minister, he gave up his title and his seat in the House of Lords and was again elected to the Commons. In 1975, Queen Elizabeth II gave him the title Baron Home of the Hirsel, and he returned to the House of Lords.

Home was born in London. His full name is Alexander Frederick Douglas-Home. He grew up at his family's ancestral home in Berwickshire in Borders Region, Scotland.

Home computer. See **Computer.**

Home Guard was a force raised in Britain in 1940 to supplement the regular armed forces during World War II. Their duties were to defend the territory near their homes, to guard against parachute invaders, and to hold strategic points. The Home Guard consisted mainly of volunteers. It was badly equipped at first. Later, the Home Guard helped operate coastal and anti-aircraft batteries. It was disbanded late in 1945.

Home rule, in Great Britain, refers to political movements in Ireland, Scotland, and Wales. The Irish home-rule movement began in the late 1800's. It aimed to gain a measure of independence for Ireland from British rule. The Republic of Ireland, which consisted of Ireland's southern counties, cut all ties with Britain in 1949. Home-rule movements gained strength in Scotland and Wales in the 1970's. Some people want complete independence from Britain. But most Scots and Welsh who favour home rule call for increased regional control over government affairs.

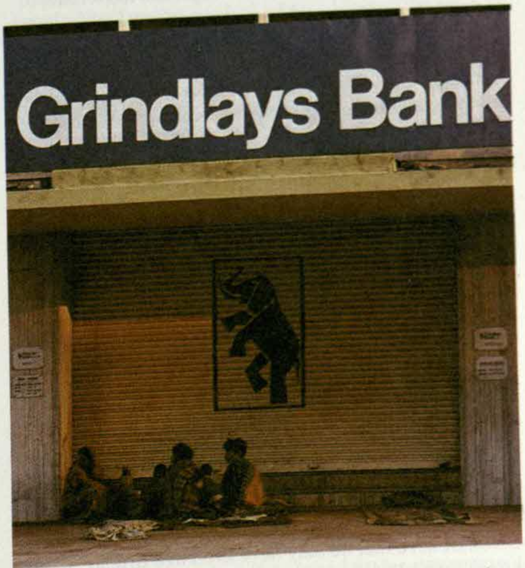
See also **Local government; Ireland; Scotland.**

Homelands. See **South African homelands.**

Homelessness is the condition of someone who has no permanent address. Homeless people often live in abandoned buildings, areas under bridges, bus stations, cheap hotels, emergency shelters, and the streets. Some sociologists use the word *homeless* to describe anyone who leads an isolated life, without the usual social ties to family, work, and community life. The United Nations reports that there are over 100 million homeless people worldwide. The problem is especially severe in developing countries.

In many countries, homelessness has become a serious problem. Some homeless people are stranded only for a short time. Others may be homeless a number of times in their lives. Still others are permanently homeless. The main causes of homelessness are unemployment, severe shortages of low-income housing, widespread poverty, and untreated mental illness. Divorce, drug abuse, and other personal and family difficulties may also lead to homelessness.

Homelessness is more a problem of cities than the countryside. People go to a city in search of work. In many industrialized countries young people are a large proportion of city homeless. In developing countries whole families may move to a city and become home-



A homeless family in India finds shelter in the doorway of a bank. Many people become homeless when they move to big cities in search of work.

less. The United Nations Commission on Human Settlements is working worldwide to improve living conditions for the homeless.

Homeopathy is a system of medical practice based on the attempt to "let like cure like." According to homeopathic doctors, a substance that produces certain symptoms in a healthy individual will cure those symptoms in a sick individual. Some plants, for example, cause rashes. Homeopathic doctors thus treat rashes with those plants. Onions cause crying and a watery discharge from the nose. Therefore, onions are used to treat colds. Samuel Hahnemann, a German doctor, developed homeopathy in the late 1700's (see **Hahnemann, Samuel**).

Homeopathic remedies are discovered through a process called *proving.* In proving, various substances are administered to healthy people and their effects carefully observed. Homeopathic doctors give patients only one remedy at a time. They believe that using combinations of remedies interferes with the effectiveness of each particular remedy. Remedies are diluted so that the patient receives the minimum effective dose. This procedure is thought to maximize the benefits of the treatment. It also helps prevent harmful side effects.

Many homeopathic remedies contain substances that could be toxic or hazardous to people if given in larger doses. In addition, the medical effectiveness of homeopathic treatments has not been scientifically proven. For these reasons, homeopathy has been criticized by many doctors.

Homeostasis is a term that refers to the ability of a living organism to maintain a stable set of conditions inside its body. In an animal, for example, such internal conditions as body temperature, blood pressure, and the composition of body fluids must remain relatively stable. A change in these internal conditions could result in disease or death.

To maintain homeostasis, an organism must react to its external environment by making internal adjustments. Such adjustments are triggered by *homeostatic reflexes.* An example of homeostatic reflexes occurs when a person steps outside on a hot day. If the body did not adjust to the heat, body temperature would rise so high that cells, especially brain cells, would die at a massive rate. However, homeostatic reflexes help maintain a constant internal body temperature. When the heat from the sun strikes the skin, nerve endings sense that heat and send a message to the brain. The brain sends nerve impulses that cause the blood vessels in the skin to expand. The resulting increase in blood flow to the skin produces greater heat loss from the skin surface. The brain also instructs the sweat glands to increase production, because the evaporation of sweat cools the skin. The brain also initiates behavioural responses that make the person want to decrease physical activity and seek a cool place.

See also **Motivation** (Kinds of motives).

Homer is traditionally considered the ancient Greek poet who composed the great epics the *Iliad* and the *Odyssey.* Scholars know almost nothing about Homer. Some believe that he may have lived in a Greek-speaking city on the eastern shore of the Aegean Sea or on the island of Khíos. Other scholars deny that he ever existed. According to tradition, Homer was blind.

Roman copy of a marble sculpture by an unknown Greek artist

Homer

Homer's poems. The events in the *Iliad* and the *Odyssey* occur during and after the Trojan War. This war was fought between Greece and the city of Troy, perhaps in the mid-1200's B.C. Many scholars believe the poems were composed between 800 and 700 B.C. They base these dates on references in the poems to social conditions at that time.

Archaeologists have discovered evidence in the ruins of Troy and ancient Greece that confirms the historical basis for some things described in the poems. But the poems' characters and events—even if partly based on real people and historical incidents—were altered over the centuries in the retelling of folk tales and in the poems of singing poets called *bards.* The bards created a series of poems called the *Trojan cycle,* which told the entire story of the Trojan War. The *Iliad* and the *Odyssey* are the only surviving parts of the cycle.

After Homer's time, the two poems were recited as part of great religious festivals in Greece. Copies of the poems became the basic textbooks that Greek children used to learn to read and to study the legends and myths of ancient Greece. As a result, the Greeks formed their religious views from Homer's portrayals of the gods and goddesses. His poems also furnished characters and plots for the great tragic dramatists of the 400's B.C.—Aeschylus, Euripides, and Sophocles.

Early scholarship. The Greek people came to know Homer's poems by hearing them recited or by reading handwritten copies of them. In making copies, writers sometimes made mistakes or deliberate changes in the text. By 300 B.C., many slightly different versions of the *Iliad* and the *Odyssey* existed in Greece.

From about 300 B.C. to about 100 B.C., scholars at the great Alexandrian Library in Egypt tried to correct the changes in the two poems and restore them to their original form. A few scholars came to believe that the poems were the work of two poets. These scholars, called *separatists,* felt that the language, point of view, and subject matter of the two poems differed so greatly that they could not have been created by one person.

Analysts and unitarians. For many centuries, the question of who composed the *Iliad* and the *Odyssey* was almost forgotten. Then, in 1795, German scholar Friedrich August Wolf revived the issue. He said archaeologists had no evidence that the Greeks knew how to write when Homer was supposed to have lived. Wolf argued that such long poems as the *Iliad* and the *Odyssey* could not have been composed without the knowledge of writing. He led a school of critics called *analysts,* who developed a theory that Homer never existed. They believed the *Iliad* and the *Odyssey* were collections of short songs by several poets. The analysts insisted that inconsistencies in the stories and variations in language showed many authors were involved.

A second group of scholars, called *unitarians,* opposed the analysts. The unitarians insisted that both

Winslow Homer painted many scenes of rural American life early in his career. *Snap the Whip, left,* pictures New England farm children in the naturalistic style characteristic of Homer's works.

Oil painting on canvas (1872); The Butler Art Institute of American Art, Youngstown, Ohio

poems were the work of one poetic genius or, at most, of two great poets. They stressed the unified overall plan of the poems and the consistent character portrayals. The dispute between the analysts and the unitarians became known as the *Homeric question.*

The Homeric question today has been greatly influenced by our increased knowledge of how oral poetry is created. During the 1930's, an American scholar named Milman Parry began studying the bards of Serbia. These bards were *illiterate* (unable to read or write), but they composed long poems orally. They did not memorize their poems in their entirety, but re-created them in slightly different form at each recitation. In creating their plots, the Serb bards used and reused many traditional phrases, lines, and scenes. Through his studies, Parry was able to point out that the *Iliad* and the *Odyssey* both share these characteristics, though on a much larger scale.

Parry's studies have been developed by other scholars into a theory that Homer was an illiterate bard of exceptional ability. According to this theory, Homer sang the stories of the *Iliad* and the *Odyssey* on many occasions. Toward the end of his life, writing was introduced into Greece. Homer then dictated the *Iliad* and the *Odyssey.* The poems were written in a form of Greek that does not belong to any one city or historical period. This fact has complicated attempts to trace the details of Homer's life.

Most scholars today agree that the *Iliad* and the *Odyssey* reflect an oral tradition. But they still disagree over details of how the poems were composed or preserved.

See also **Iliad; Odyssey.**

Homer, Winslow (1836-1910), was an American artist. He became famous for paintings of the sea that are remarkable for their intensity of feeling and stirring grandeur. He never painted fishermen and sea captains as individuals, but as symbols of the rugged quality of all people who follow the sea. In the same way, his vision of the sea is not local, but universal. Homer took American art out of the romanticism of the mid-1800's and carried it to the most powerful heights of realism. His painting *The Gulf Stream* is shown in the **Painting** article.

Homer was born in Boston. He was apprenticed to a lithographer in 1854 and became a freelance illustrator in 1857. By 1859, he was living in New York City. There he worked for *Harper's Weekly,* which employed him during the American Civil War to illustrate battlefield scenes. Homer did many war illustrations. At the same time, he painted his first oils, which are scenes of farm and country life. He began painting watercolours of these subjects in 1873.

Homer spent 10 months in Paris in 1867. He was not deeply influenced by his Paris stay, but his figure style was affected by the heroic peasants painted by the French artist Jean François Millet. A trip to the coastal town of Tynemouth, England, in 1881 and 1882 centred Homer's interest on the sea.

Returning to America, Homer settled permanently at Prout's Neck on the coast of Maine. Most of his sea paintings were done at Prout's Neck. Homer often travelled to the Adirondack Mountains and to Florida, Bermuda, and Nassau. He developed his watercolour technique on these trips. He skilfully applied transparent *washes* (liquids) to instil a dramatic quality and fine feeling for light.

Homestead Act was passed by the United States Congress in May 1862. It provided that any person over 21, who was the head of a family, and either a U.S. citizen or an alien who intended to become a citizen, could obtain the title to 65 hectares of public land if he or she lived on the land for five years and improved it. Or, the settler could pay 1.25 U.S. dollars per acre (0.4 hectare) in place of the residence requirement.

The sponsors of this law believed that land was worthless before it was improved, and that people who converted unoccupied land into farms should not have to pay for the land. They also hoped that the law would help workers obtain *homesteads* (small farms) of their own.

Background. The demand that the government grant free land to settlers began during colonial times. After the American Revolution, the United States government regarded its public lands simply as a way of gaining money. This policy met with considerable opposition from farmers. They wanted the government at least to sell the land at a low price.

In the 1840's and 1850's, the homestead movement became a national political issue. Proposals for a homestead law were often introduced in Congress. But questions of land policy became involved with the slavery issue, and most Southerners opposed the bills. When the Southern States seceded from the Union, passage of a homestead law became inevitable.

Effects of the law. The Homestead Act attracted thousands of settlers to the West. From 1862 until 1900, it provided farms and new homes for between 400,000 and 600,000 families. The opportunities offered by the act were widely advertised in America and Europe. On the whole, however, the act proved a disappointment to the people who supported it. Through a series of other laws, Congress granted much of the best land in the West to railway builders or to the states for the support of agricultural colleges. Workers were not attracted to the West.

Those who tried to develop homesteads in the West faced unexpected problems. They were not used to farming conditions on the plains. Farmers often had to use irrigation because rainfall was scarce. The development of farm machinery made a farm of only 65 hectares uneconomical. Some homesteaders sold their land to speculators because of the many problems.

Beginning in 1873, Congress passed a series of new measures that modified the act of 1862. These measures allowed the people to acquire larger tracts of land. But the chief beneficiaries were speculators and others who sought control of the natural resources of the West. Some historians question the value of the act because of the widespread abuses. Of the public lands that passed into private hands from 1862 to 1900, not more than 11 to 17 per cent was settled by homesteaders.

Much of the homesteading during the 1900's took place in Alaska. Many homesteaders acquired free land in the Anchorage area. The U.S. government ended the homesteading programme in 1976 for all states except Alaska. The Homestead Act expired in Alaska in 1986, and homesteading has been stopped there until all land claims by Alaska's native Eskimos, Indians, and Aleuts have been satisfied.

See also **Pre-emption; Westward movement.**

Homicide is the killing of one person by another. Homicide can be lawful or unlawful. *Unlawful homicide* is usually murder or manslaughter, but other forms include infanticide and causing death by dangerous driving. Infanticide is the killing of a young child by its mother.

A person who finds a burglar attempting to force a way into his or her home has a legal right to use reasonable force to prevent a crime being committed, and to defend him or herself and his or her property. But if the burglar is killed, it is still a homicide. If a child dashes in front of a truck and gets killed, the truck driver may be entirely blameless, but the driver has nevertheless committed a homicide. When a person who kills another is found to have acted within his or her rights, the killing is considered a *lawful* or *justifiable homicide.* Whether the amount of force used is reasonable depends on the circumstances.

Another form of lawful homicide is killing a person who has been sentenced to death by law. But the killing must be carried out in the proper manner under the law.

See also **Manslaughter; Murder.**

Homing pigeons carry messages in a holder attached to the leg or back. They can fly up to 97 kilometres an hour.

Homing pigeon is a special breed of pigeon developed for racing and carrying messages. These pigeons are sometimes called *homers.* They can be trained to return to their home loft when released from a distant place. This homing ability has been greatly increased by selective breeding. Homing pigeons are descended from the rock pigeon that lives wild in Europe, Asia, and Africa.

The homing ability. No one knows exactly how pigeons and other birds find their way across strange territory to reach home. Homing pigeons have been known to fly more than 1,600 kilometres in two days. This would not allow much time for random searching, so they somehow know the proper direction to take. Some people believe these birds have a mysterious ability to orient themselves with the earth's magnetic field. But there is no real proof of this. Others think the birds are guided by the position of the sun. Just how they do this is not clear, but birds may lose their way in cloudy or foggy weather. Homing pigeons have a highly developed ability to recall visible landmarks. But this does not explain their homing over unfamiliar country.

Pigeon racing. Many people enjoy racing homing pigeons, and often organize races that cover as much as 1000 kilometres. Although homing pigeons have been bred for their homing ability, additional training of individual birds is important. Trainers first allow the young pigeons to become familiar with the area near the home loft. Then they take the birds 10 to 15 kilometres away and release them. They gradually increase the distance the bird must fly to reach its home loft.

If the birds are to be raced, the owner trains them over the area in which the race is to be held. Only the most successful homers are entered in competitions. The trainer chooses birds that are in the finest physical condition and have perfect, unbroken flight feathers. Some birds have flown nearly 1,000 kilometres in one day, without stopping to eat or drink. Pigeons two or three years old make the speediest racers. But older birds perform better in bad weather. Birds with young in the nest are especially dependable homers. It appears that their concern for the young makes them anxious to return.

In official races, clocking devices record the time at which the birds reach their home loft. Upon reaching home, the bird must enter the loft at once so that the owner can remove its band and record the time.

History. Homing pigeons carried messages for the ancient Egyptians and Persians 3,000 years ago. In Greece, pigeons carried news of Olympic games victories to the different cities. The Romans used them to send military messages. During the Franco-Prussian War, the French used homing pigeons, and the Germans trained hawks to catch them. Homing pigeons served the U.S. Signal Corps in World Wars I and II and in the Korean War. During World War I, amazing stories of pigeons delivering messages during combat were recorded. One bird carried a message about 40 kilometres in 25 minutes. It arrived with one leg shot off and its breast injured by a bullet.

See also **Pigeon** (picture); **Reuter, Baron de.**

Hominy is a food made from hulled maize. It is popular in the Southern United States. The maize is soaked in a weak lye solution. This causes the kernels to puff up. The skins come free and float to the top. After the kernels are washed, they are ready to be cooked. Hominy may be boiled or fried, and is usually served with meat. In the U.S.A., ground hominy is called *grits.*

Homo erectus is regarded by most anthropologists as a species of human being that lived from about 1 ½ million to 300,000 years ago. *Homo erectus* resembled people of today but had a slightly smaller brain and slightly larger teeth. *Homo erectus* stood over 150 centimetres tall and walked upright. The Latin word *homo* means *human being. Erectus* means *upright* and refers to the creature's erect posture.

Homo erectus made stone tools, including axes. These early people were probably the first human beings to master the use of fire. They originated in Africa and became the first people to migrate from that continent, eventually reaching northern Asia and Europe.

Fossils of *Homo erectus* were first found in 1891 in Java (now Indonesia) by Eugène Dubois, a Dutch doctor (see **Java man**). Other famous *Homo erectus* fossils were found near Heidelberg, Germany; and near Peking, China (see **Heidelberg man; Peking man**).

In 1984, two almost complete *Homo erectus* skeletons were found. One was uncovered at Lake Turkana in Kenya by the palaeontologists Richard Leakey of Kenya and Alan Walker of Great Britain. The bones were about 1 ½ million years old, one of the oldest *Homo erectus* specimens ever found. The lack of adult teeth indicated that the person died at about the age of 12. The size of the thighbone suggested that the person was already about 168 centimetres tall. This skeleton, which lacked some bones from the arms and feet, is the most complete skeleton of an early ancestor ever found. The other skeleton found in 1984 was uncovered in northeastern China. It lacked arm and leg bones and was about 300,000 years old. These discoveries gave scientists their first opportunity to study bones from a young person of the species, as well as bones from all parts of the skeleton instead of just teeth and the skull.

Many scientists believe that *Homo erectus* developed from a type of prehistoric human being known as *Homo habilis* (skilful human being). In turn, *Homo erectus* was an ancestor of our own species, called *Homo sapiens* (wise human being).

Homo habilis is considered by most anthropologists to be the oldest type of human being. Fossil evidence indicates that these prehistoric people lived in Africa about 2 million years ago. The Latin word *homo* means *human being. Habilis* means *skilful* or *handy.* Scientists gave *Homo habilis* this name because its fossils have been found along with some of the earliest known stone tools. The findings suggest that *Homo habilis* made the first such tools.

The first *Homo habilis* fossils were found at Olduvai Gorge in Tanzania in 1960 by the British anthropologist Mary Leakey, wife of the anthropologist Louis Leakey, and one of their sons, Jonathan. Other *Homo habilis* fossils have been discovered at Lake Turkana in Kenya and at other sites in eastern and southern Africa. The oldest known *Homo habilis* fossil is part of the skull of a person who lived about 1,900,000 years ago. Richard Leakey, another son of Louis and Mary Leakey, found this fossil at Lake Turkana in 1972. Scientists refer to the skull as ER-1470.

In 1987, anthropologists reported the first discovery of *Homo habilis* skull bones and limb bones from the same person. The discovery, also made at Olduvai Gorge, included arm bones that were relatively long compared with the thighbones. Some scientists concluded that *Homo habilis* was more apelike than previously thought and probably spent a lot of time in trees.

Many anthropologists believe that *Homo habilis* developed from humanlike creatures called *australopithecines. Homo habilis* had a brain larger than that of an australopithecine but only a little more than half the size of a modern human brain. Many scientists believe that *Homo habilis,* in turn, developed into a more advanced type of prehistoric human being known as *Homo erectus* (erect human being). *Homo erectus* appeared in eastern Africa about 1 ½ million years ago.

See also **Australopithecus; Homo erectus; Leakey family; Prehistoric people** (Primitive human beings).

Homogenization is the breaking up of particles in an emulsion so that they are small enough not to separate. An *emulsion* is a mixture in which one liquid is scattered in the form of tiny globules throughout another liquid. Milk is an emulsion of butterfat in water. The butterfat separates to form a layer of cream. To prevent separation, milk is forced through a narrow opening at high pressure. This breaks the large globules into small ones.

See also **Milk** (At a processing plant); **Emulsion.**

Homologous structures are structures that have an essential similarity and develop in the same general way. For example, the flipper of a seal and the foreleg of a dog have the same basic structure. The legs of a turtle and the wings of a bird are also homologous, but they have different uses. Organs that have similar uses but are not similar in structure are said to be *analogous.* The wings of birds and the wings of insects are analogous structures.

Homonym is a word having the same spelling and pronunciation as another word or words, but a different meaning. Examples are *bark* (of a dog) and *bark* (of a tree); and *rest* (relief from activity) and *rest* (remainder).

Some linguists include *homophones* in their definition of homonyms. Homophones are words with the same pronunciation but different spellings and meanings (*site, cite, sight*). In addition, some linguists include *heteronyms* in their definition of homonyms. Heteronyms are words with the same spellings but different pronunciations (see **Heteronym**).

Homoptera. See **Insect** (table).

Homosexuality is the condition of being sexually attracted to individuals of the same sex. Both men and women may be homosexuals. Female homosexuals are often called *lesbians.* Both male and female homosexuals are sometimes referred to as *gay.* Scientists estimate that 10 per cent of men are exclusively homosexual. About 6 per cent of women are believed to prefer their own sex.

Some people are not entirely homosexual or entirely *heterosexual* (sexually attracted to the opposite sex). Some homosexuals marry individuals of the opposite sex and have children. Many heterosexuals have participated in some kind of homosexual activity at some time in their lives. People who are regularly attracted to members of both sexes are called *bisexuals.*

It is fairly common for young boys—and, less frequently, for young girls—to *masturbate* (handle or rub their sex organs). Boys may stimulate each other in this way, and so may girls. Such activity rarely indicates a homosexual preference. In almost every case, the young people are simply exploring their own sexual development. See **Sex** (Puberty).

Some homosexual behaviour results from the unavailability of partners of the opposite sex and does not necessarily reflect a true homosexual preference. For example, a person who spends long periods separated from the opposite sex may turn to members of his or her own sex for sexual partners. Such situations may occur in prisons, the armed forces, and some boarding schools.

Most homosexuals appear no different from other members of their own sex. But some behave, dress, and talk like members of the opposite sex. Many homosexuals hide their sexual preference. Others join gay groups. Often two homosexuals establish a long-term relationship that is similar to marriage.

Causes of homosexuality are not fully understood. Many experts believe people have natural sexual *orientations* (inclinations) that range from strictly heterosexual to strictly homosexual. Many psychiatrists believe most people fall somewhere between these two extremes, and either homosexuality or heterosexuality eventually becomes the dominant sexual orientation.

Most experts feel that a number of different factors can lead to homosexuality. Some researchers have suggested that homosexuality results chiefly from biological factors. They claim that an individual's response to chemicals in the mother's blood while developing in the womb influences the individual's sexual orientation. Studies have shown that homosexuals have normal chromosomes, but some researchers believe there may be a genetic factor in the condition. Other researchers believe homosexuality is associated primarily with psychological factors. For example, according to one theory, children can learn to be attracted to either of the sexes or to both sexes. They are taught heterosexuality as they learn the role of their sex in society. But some have experiences that lead to mistrust or fear of the opposite sex. Others find it hard to identify with their sex's role in society.

Homosexuality may be more comfortable than heterosexuality for many men and women. Some people try to change their sexual orientation through psychiatric treatment. But learning to manage one's feelings and life style may be a more realistic goal. Homosexuality is so common that it is no longer regarded as a psychological disorder.

Attitudes toward homosexuality. Throughout history, homosexuality has existed in most societies. Various cultures have differed in their attitudes toward it. For example, some ancient Greeks not only accepted homosexuality but considered it to be an ideal relationship—perhaps because ancient Greek men were taught to consider women inferior. Such men believed that only men could fulfil the role of true friend and lover. Other cultures have permitted homosexuality but have not encouraged it. Still others have forbidden it, and some have punished homosexuals.

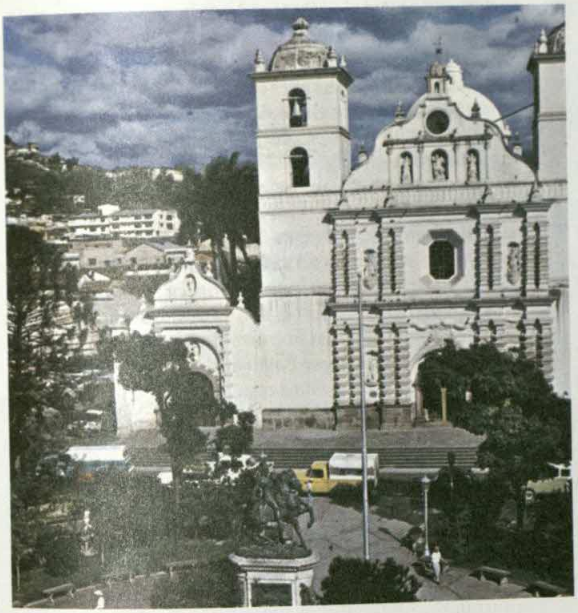
Today, many people in most countries consider homosexuality immoral or unnatural. Many social scientists oppose laws that prohibit homosexuality and provide punishment for it. These scientists believe that homosexuals are treated unfairly for ways of life that do not directly affect others. Many nations, including England, France, the Netherlands, Sweden, and Canada, have no laws against homosexual acts between consenting adults. Since the 1960's, homosexual groups—sometimes called Gay Liberation groups—have urged society to adopt more tolerant attitudes. As a result of the movement, many countries passed laws in the 1970's banning discrimination against homosexuals in employment, housing, and other fields.

During the 1980's, however, the gay rights movement suffered a setback as an epidemic of AIDS (Acquired Immune Deficiency Syndrome) swept the United States, and then many other nations. This disease, which was first identified in 1981 in the United States, cripples the body's immune system and is usually fatal. Although AIDS also occurs among—and is transmitted by—heterosexual men and women, many people blamed homosexuals for the spread of the disease. Many homosexuals fear more discrimination as a result of the AIDS crisis. See **AIDS**.

Hon Sui Sen (1916-1983) was a Singapore public servant and politician. He was a leading figure in transforming Singapore's economy from its traditional dependence on being a port, into a more diversified and dynamic economy. He helped to make Singapore the great commercial and financial centre it is today. In 1982, he was voted economic minister of the year by the magazine *Euromoney.*

Hon Sui Sen was born in Penang, in what is now Malaysia. He arrived in Singapore in 1932 to continue his education.

As chairman of the Economics Development Board from 1961 to 1968, he was the guiding force behind Singapore's industrialization programme to create jobs for the mass unemployed. In 1970, he retired from the civil service and entered politics. He became minister of finance and held the post for 13 years.



Honduras is a small country in Central America. Tegucigalpa, *left,* is the capital and largest city. Bananas, *right,* are the country's chief product. They grow along the northern coast.

Honduras

Honduras is a small Central American country that is known for the production of bananas. Honduras is a poor country. Its people have a low average income and more than half of them work on the land. But about a quarter of the working population is unemployed.

Large numbers of Hondurans grow bananas, the nation's leading source of income, in the northern lowlands along the Caribbean Sea. In the inland mountains, people raise cattle and grow beans, coffee, and maize.

Tegucigalpa, the capital and largest city of Honduras, is in the inland mountain region. The country has limited transportation, and Tegucigalpa is one of the few capitals in the world which has no railway service. Many Hondurans raise cattle and grow cotton on the plains bordering the Pacific Ocean in the south of the country.

Christopher Columbus arrived at Honduras in 1502. Either Columbus or a later explorer gave it the name *Honduras,* the Spanish word for *depths,* because of the deep waters of the Caribbean Sea off the northern coast.

Government

The Constitution of Honduras was adopted in 1982. Under the Constitution, the people elect a president to head the government and a legislature to make the country's laws. The president and the members of the legislature serve four-year terms. Presidents may serve only one term. The president appoints a Cabinet, and the Cabinet members head departments that carry out the operations of the government.

The military has much influence in the government of Honduras. Military leaders in Honduras have often taken complete control of the government. See the *History* section of this article for details of the military's role in the Honduran government.

People

More than 95 per cent of all Hondurans are *mestizos* (people with both Spanish and Amerindian ancestors). Almost all mestizos speak Spanish and are Roman Catholics. In the northern banana-growing areas and ports, many people can speak English. They learned English to do business with United States fruit companies.

About 20,000 Miskito people live in thinly populated northeastern Honduras. This group is a mixture of indigenous people, freed black slaves, and other groups. They speak the Miskito language. All are Christians, and many belong to the Moravian Church, a Protestant sect.

Garifuna, or Black Caribs, dwell along the northwest

Facts in brief about Honduras

Capital: Tegucigalpa.

Official language: Spanish.

Area: 112,088 km². *Greatest distances*— east-west, 652 km; north-south, 386 km. *Coastlines*—Caribbean, 615 km; Pacific, 77 km.

Elevation: *Highest*—Cerro Las Minas, 2,849 m above sea level. *Lowest*—sea level along the coasts.

Population: *Estimated 1996 population*—6,132,000; density, 53 people per km²; distribution, 52 per cent rural, 48 per cent urban. *1988 census*—4,248,561. *Estimated 2001 population*—7,016,000.

Chief products: *Agriculture*—bananas, beans, beef and dairy cattle, coffee, cotton, maize, milk, sugar cane, tobacco. *Manufacturing*—clothing and textiles, processed foods and beverages, timber. *Mining*—silver.

National holiday: Independence Day, September 15.

National anthem: "Himno Nacional de Honduras" ("National Hymn of Honduras").

Money: *Currency unit*—lempira. One lempira = 100 centavos.

Honduras is a land of small farms. Swiftly growing vegetation is burned back, *above,* before crops can be planted.

ern coast of Honduras. These people are descended from black slaves and Arawak Indians. The Garifuna speak an Arawak language, but most also speak Spanish, English, or both.

The people of the Bay Islands, which lie off the northern coast, are mostly English-speaking Protestants.

About 60 per cent of the people of Honduras live in rural areas. Among all the countries in the Western Hemisphere, Honduras has one of the highest percentages of rural dwellers. Most rural Hondurans are poor peasants who own or rent small farms. These people have poor transportation and communication, and are cut off from the cities. Modernizing changes are taking place in the cities because of expanding industry and education. But such changes are only slowly reaching the farm communities. Most rural Hondurans live in small houses made of *adobe* (mud), boards, or poles, or of earth and stones packed into a wooden frame.

Education. Honduran law requires children to go to school from the ages of 7 to 12, but many do not do so. Honduras does not have enough schools, especially in the rural areas, and about 43 per cent of all adult Hondurans cannot read and write.

The country's only university, the National Autonomous University of Honduras, was founded in Tegucigalpa in 1847. It has about 27,000 students. The Pan American Agricultural School is near the capital.

Population. About 5 million people live in Honduras. The country's population is increasing at the rapid rate of about 3 per cent annually.

Tegucigalpa, which has a population of about 300,000, is the capital and largest city. Other large cities include El Progreso, La Ceiba, and San Pedro Sula.

Land

Honduras has four main land regions: (1) the Mountainous Interior, (2) the Northern Coast, (3) the Northeastern Plain, and (4) the Southern Coast.

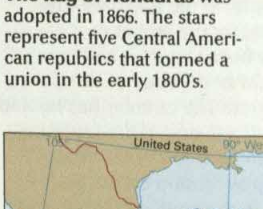
The Mountainous Interior covers over 60 per cent of Honduras. The country's highest point is 2,849 metres above sea level in the Cerros de Celaque, a mountain range. Forests of oaks and pines cover slopes below 2,100 metres. Above the oak and pine forests are forests of broadleaf evergreens or, where these *cloud forests* have been cut down, scrub pines now flourish.

Honduras has no active volcanoes, though neighbouring countries do. As a result, Honduras lacks soils which are made especially fertile by volcanic ash. But a number of small upland valleys in the Mountainous Interior have rich fertile soils that support many farmers.

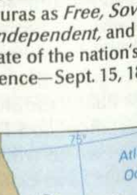
The Northern Coast is the banana-producing region of Honduras. The most important banana areas are the Ulua-Chamelecón River Basin and the coastal plain near Tela. San Pedro Sula, the second largest city in Honduras, is the region's major commercial centre. Nearby Puerto Cortés is the country's leading port. The Northern Coast has the only railways in Honduras. The railways, built chiefly to carry bananas from plantations to the ports, extend only about 105 kilometres inland.

East of Tela, the region is largely undeveloped and sparsely populated.

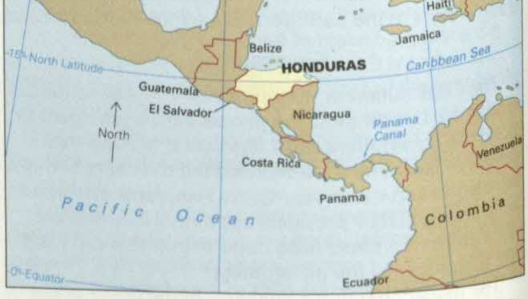
The Northeastern Plain is the least developed and most thinly populated region of Honduras. It has some small Indian communities and a few little towns. Tropical rainforests cover much of the region. They make up



The flag of Honduras was adopted in 1866. The stars represent five Central American republics that formed a union in the early 1800's.



The coat of arms describes Honduras as *Free, Sovereign, and Independent,* and shows the date of the nation's independence—Sept. 15, 1821.



Honduras in Central America has a long coastline on the Caribbean Sea, and a short coastline on the Pacific Ocean.

a hot, wet area called the Mosquito Coast, or Mosquitia.

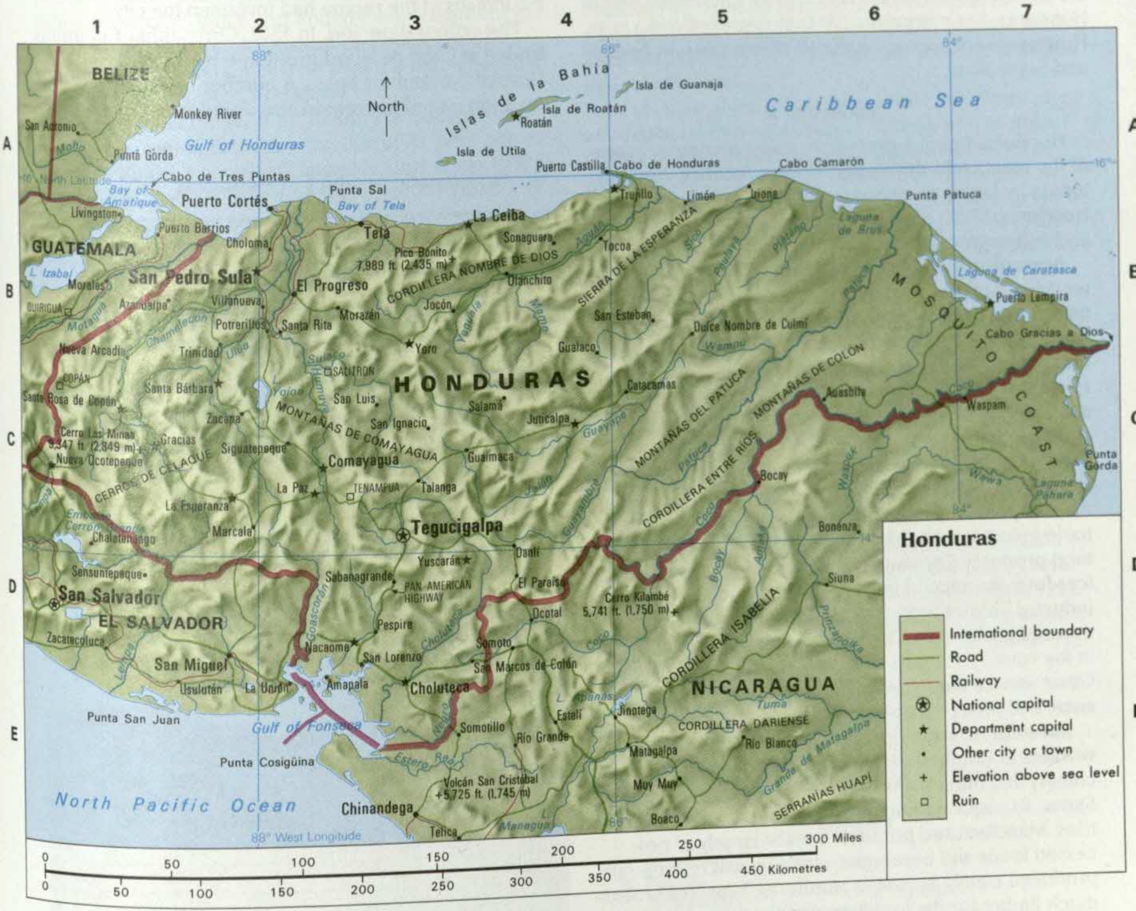
The border with Nicaragua was disputed until 1960. The International Court of Justice in the Netherlands decided in favour of the Honduran claim, and the border was established at the Coco, or Wanks, River. Honduras also owns the Swan Islands in the Caribbean Sea.

The Southern Coast, on the Gulf of Fonseca, is Honduras' only outlet to the Pacific Ocean. Mangrove trees grow along the shoreline, behind which lie narrow plains. The largest plain, that of the Choluteca River in the Choluteca department, has rich soils that support many farms and cattle ranches. The Pacific Ocean port, of Amapala, is on an island in the Gulf of Fonseca.

Climate

Honduras has a tropical climate that becomes cooler in the mountains with the increase of altitude. The coastal lowlands have an average yearly temperature of 31° C, with little seasonal change. Tegucigalpa has an average of 23° C. The capital's temperature rarely rises above 32° C and seldom falls below 10° C. The highland areas are mild.

The rainy season begins in May. It ends by December in the southern and central highlands, which receive a yearly average of 75 to 150 centimetres of rain. The rain falls until February in the north, and almost throughout



Honduras map index

Departments

Atlántida	262,227	B	3
Choluteca	306,939	E	3
Colón	138,473	B	5
Comayagua	226,259	C	3
Copán	227,997	C	1
Cortés	683,025	B	2
El Paraíso	218,296	D	4
Francisco Morazán	792,227	C	3
Gracias a Dios	38,681	B	6
Intibucá	115,677	C	2
Islas de la Bahía	19,674	A	4
La Paz	89,089	C	2
Lempira	181,849	C	1
Ocotepeque	65,418	C	1
Olancho	242,880	C	4
Santa Bárbara	305,461	A	2
Valle	130,795	D	2
Yoro	327,520	B	3

Cities and towns

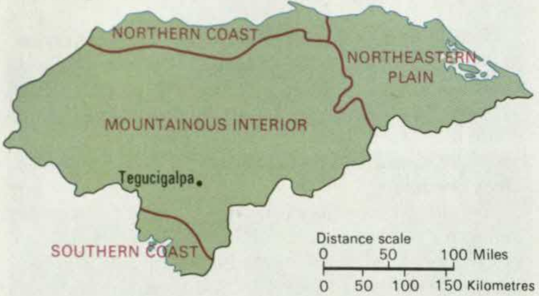
Catacamas	9,081	C	4
Choluteca	57,200	E	3
Comayagua	28,800	C	2
El Paraíso	9,601	B	3
El Paraíso	6,717	D	4
El Progreso	55,500	B	2
Gracias	2,332	C	1
Juticalpa	13,800	C	4
La Ceiba	61,900	B	3
La Paz	6,674	C	2
Nacaome	5,894	D	2
Nueva Ocotepeque	4,618	C	1
Olanchito	12,400	B	4
Potrerillos	5,365	B	2
Puerto Cortés	39,900	A	2
Roatán	1,952	A	4
San Lorenzo	9,261	D	3
San Marcos de Colón	4,397	E	3
San Pedro Sula	372,800	B	2
Santa Bárbara	5,910	C	2
Santa Rosa de Copán	19,400	C	1
Siguatepeque	24,100	C	2
Talanga	4,805	C	3
Tegucigalpa	571,400	D	3
Tela	26,700	B	3
Trujillo	4,019	A	4
Villanueva	4,896	B	2
Yoro	4,429	B	3
Yuscarán	1,831	D	3

Physical features

Aguán, (river)	B	4
Bahía, Islas de la (islands)	A	4
Bay Islands, see Bahía, Islas de la		
Bay of Tela	A	3
Cabo Camarón (cape)	A	6
Cabo de Honduras (cape)	A	4
Caribbean Sea	A	6
Cerros de Celaque (mountains)	C	1
Chamelecón (river)	B	1
Coco (river)	C	6
Guanaja, Isla de (island)	A	5
Guayape (river)	C	4
Gulf of Fonseca	E	2
Gulf of Honduras	A	2
Jalán (river)	C	4
Laguna de Brus (lagoon)	B	6
Laguna de Caratasca (lagoon)	B	7
Lake Yojoa	C	3
Montañas de Colón (mountains)	C	5
Montañas de Comayagua (mountains)	C	3
Mosquito Coast	B	6
Negro (river)	E	3
Patuca (river)	B	6
Roatán, Isla de (island)	A	4
Sico (river)	B	5
Sierra de la Esperanza (mountains)	B	4
Ulúa (river)	B	3
Utila, Isla de (island)	A	4

Sources: 1985 official estimates for departments and largest cities; 1974 census for other places.

Land regions of Honduras



the year in the northeast. That region, the wettest part of Honduras, has more than 250 centimetres of rain a year. Hurricanes sometimes hit the Northern Coast in August and September.

Economy

Honduras has few resources, and its economy is one of the most underdeveloped in Latin America. Agriculture is by far the most important economic activity in Honduras. Much of the country's income is from banana and coffee exports.

Agriculture employs more than half of all Honduran workers. Bananas account for about a third of the nation's exports, and coffee accounts for about a quarter. Maize is the people's main food. The maize crop covers more land than any other crop in Honduras. Farmers also grow beans, cotton, sugar cane, and tobacco. Beef and dairy cattle are raised. Honduras also exports shrimps, timber, and beef.

Service industries employ about a third of all Honduran workers. Wholesale and retail trade is the most important service industry. Much of the country's trade industry is based on the distribution of agricultural products. Community, social, and personal services form the second most important category of service industry. This industry includes services such as education and health care. These services are most important in the country's largest cities, especially Tegucigalpa. Other service industries include housing; finance, insurance, and property; government; and utilities.

Manufacturing employs about a seventh of the workers in Honduras. Honduras imports most of its machinery and other manufactured goods from the United States, its major trading partner, and from other countries. Manufactured products consist largely of processed foods and beverages, clothing, and textiles—all produced mainly for use in Honduras. Sawmills provide much timber for the furniture, paper, and wood products industries. Tegucigalpa and San Pedro Sula are the major manufacturing centres.

Transportation. Roads in Honduras are scarce and few are paved, especially in the rural areas. There, the people travel mainly by buses, mules, or horses. Less than 2 per cent of the people own a car. Honduran railways—operated mostly by the fruit companies—serve only the Northern Coast region. There are two international airports, at Tegucigalpa and San Pedro Sula.

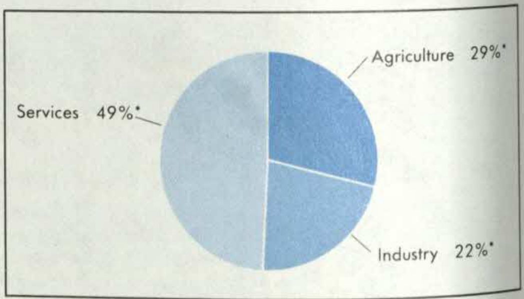
Communication. Honduras has six daily newspapers. The largest is *La Tribuna* of Tegucigalpa. Most of the radio and television stations are privately owned. Honduras has an average of about one radio for every three people. Less than 3 per cent of the people own a television set. Almost all the telephone lines are owned by the government, and are in Tegucigalpa and San Pedro Sula.

History

The Indian period. Little is known of what is now Honduras before the Spaniards arrived in the early 1500's. An eastern centre of the famous Maya Indian civilization had thrived at Copán until the 800's. Copán had beautiful stone palaces, pyramids, and temples, and its people were advanced in science and learning. But by the time the Spaniards arrived, Copán lay in ruins, and the Indians of the region had forgotten the city.

The colonial period. In 1502, Christopher Columbus landed at Cabo de Honduras (Cape Honduras). He claimed the land for Spain. A number of Spanish explorers soon visited the region and founded settlements.

Gross domestic product of Honduras



The gross domestic product (GDP) of Honduras was 3,782,000,000 U.S. dollars in 1986. The GDP is the total value of goods and services produced within a country in a year. *Services* include community, social, and personal services; finance, insurance, and property; government; housing; transportation, communication, and utilities; and wholesale and retail trade. *Industry* includes construction, manufacturing, and mining. *Agriculture* includes agriculture, forestry, and fishing.

Production and workers by economic activities

Economic activities	Per cent of GDP* produced	Employed workers Number of persons	Per cent of total
Agriculture, forestry, & fishing	29	605,900	53
Manufacturing	15	150,900	13
Wholesale & retail trade	12	110,000	10
Transportation, communication & utilities	10	49,500	4
Community, social, & personal services	9	157,200	14
Housing	7	†	†
Finance, insurance, & property	6	13,400	1
Construction	5	49,300	4
Government	5	†	†
Mining	2	4,400	1
Total	100	1,140,600	100

*Included in Community, social, and personal services.
Sources: Central Bank of Honduras; International Monetary Fund.

The Spaniards gradually conquered the Indians. Many Indians were killed, died of disease, or were shipped as slaves to plantations in the West Indies.

The Spaniards developed gold and silver mines in Honduras. They brought many black slaves from Africa to work in the mines along with the Indians. The Spaniards also developed cattle ranches to supply food to the mining centres. But the mines were not profitable enough to attract many colonists.

Independence. On Sept. 15, 1821, Honduras and four other Central American states declared their independence from Spain. They became part of the Mexican empire, but broke away from it in 1823 and formed the United Provinces of Central America. This union established some civil rights, and ended the privileges of the powerful nobility and the Roman Catholic Church. Honduras left the union in 1838 after the union began to fall apart under various pressures.

Honduras was the weakest country in Central America. It soon came under the influence of its more powerful neighbours, especially Guatemala. During the 1800's, Guatemala started or aided several revolts in Honduras.

United States fruit companies began arriving in the 1890's to grow bananas in Honduras. In the early 1900's, bananas became Honduras' leading source of income. Export taxes paid by the U.S. fruit companies took care of most of the Honduran government's expenses. The government gave the companies special privileges to increase this income, and the firms developed a strong influence over the government. The term *banana republic,* referring to several developing countries, was first used for Honduras.

Until 1933, most Honduran presidents did not serve long because of frequent revolutions. General Tiburcio Carías Andino became president in 1933 and held office for 16 years, the longest period. Carías ruled as a dictator, and several revolts failed to overthrow him.

A Maya ball court can still be seen at Copán, the site of an ancient city. The Maya played a sacred game on courts like this.

More political violence during the 1950's led to the election of Ramón Villeda Morales, a doctor, who became president in 1957. Villeda set up a land reform programme, and built hospitals, roads, and schools.

In 1963, a military revolt led by Colonel Osvaldo López Arellano overthrew the government. An elected assembly wrote a new constitution that provided for López to become president. In 1971, the voters elected Ramón Ernesto Cruz, a lawyer, to the presidency. But in 1972, the armed forces overthrew the Cruz government and López again became president.

In 1969, a Honduran land reform law forced many families from El Salvador living in Honduras to give up their land. Salvadoran troops entered Honduras in July 1969, but left in August. In 1970, the Organization of American States helped the two nations set up a neutral zone along their border. In 1992, the countries ended their border dispute.

In 1975, the armed forces removed López from office and replaced him with Colonel Juan Alberto Melgar Castro. In 1978, three leaders of the armed forces removed Melgar from office and took over the government. In 1981, elections for a civilian government were held. The people elected Roberto Suazo Córdova president and also chose a new legislature. In 1985, José Azcona Hoyo succeeded Suazo as president.

Recent developments. In the 1980's, Honduras became a site of clashes between troops of the Sandinista government of Nicaragua and Nicaraguan rebels who were trying to overthrow the Sandinistas. The rebels, called *contras,* established guerrilla bases in Honduras. Sandinista troops sometimes entered Honduras to attack the contras. In 1989, Rafael Leonardo Callejas was elected president of Honduras. In 1990, the Sandinista government was voted out of office. The contra bases in Honduras were then shut down.

Since 1981, the voters of Honduras have elected a new president and legislature every four years. Carlos Roberto Reina Idiaquez was elected president in 1993. A member of the centre-right Liberal Party, he pledged to continue economic reforms and reduce the powers of the Honduran army.

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Central America
Latin America
Maya
Mosquito Coast
San Pedro Sula
Tegucigalpa
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Outline

I. Government
II. People
- A. Education
- B. Population

III. Land
- A. The Mountainous Interior
- B. The Northern Coast
- C. The Northeastern Plain
- D. The Southern Coast

IV. Climate
V. Economy
- A. Agriculture
- B. Service industries
- C. Manufacturing
- D. Transportation
- E. Communication

VI. History

Hone is the name of an Irish family that has been associated with the arts since the 1700's.

Nathaniel Hone (1718-1784) painted miniature portraits. He worked in Ireland and England and studied in

Italy. In 1752, he exhibited at the Royal Academy, in London, of which he was a founder member. Nathaniel Hone was born in Dublin. Two of his sons, Horace (1756-1825) and John Camillus (1759-1836), were also portrait painters.

Evie Hone (1894-1955), a descendant of Nathaniel Hone, was noted for her stained glass. She was born in Dublin. Her work includes the east window of Eton College Chapel, in Berkshire, England, and the Alpha and Omega window in University Hall Chapel, Dublin.

Hone Heke Pokai (1810?-1850) was a famous Maori chief whose dislike of British (United Kingdom) rule led to the first of the New Zealand Wars. Heke, the chief of the Ngapuhi tribe, was a nephew of another famous warrior chief, Hongi Hika. Heke considered that the conditions of the Maori people worsened after the Treaty of Waitangi. In July 1844, he cut down a flagstaff flying the Union Jack at Kororareka (now Russell). The British governor, Robert FitzRoy, ordered the flagstaff to be reerected. But in January 1845, Heke cut it down twice more. FitzRoy offered a reward to anyone who captured Heke. In turn, Heke offered a reward to anyone who brought him the governor's head. British troops reerected the flagstaff and fortified it. On March 11, 1845, Heke captured the flagstaff. He then plundered Kororareka. This revolt began the New Zealand Northern War. British soldiers, assisted by pro-British Maori, attacked Heke's forces. In November 1845, George Grey, the new governor, led a British force in a successful attack on Heke's fort at Ruapekapeka and forced him to make peace.

Honecker, Erich (1912-1994), was the leader of East Germany from 1971 until 1989. He came to power when he succeeded Walter Ulbricht as first secretary (later general secretary) of the ruling Communist Party. In the 1980's, large numbers of East Germans became increasingly dissatisfied with the lack of freedom under Honecker's rule. In 1989, many of them fled to West Germany. In October 1989, Honecker was forced to resign as general secretary. In December, he was expelled from the Communist Party. In 1990, East and West Germany were reunified into the single nation of Germany. After reunification, Germany charged Honecker with manslaughter for ordering border guards to shoot East Germans trying to escape to West Germany during his leadership. His trial began in late 1992, but ill health soon prevented him from attending. In January 1993, Germany suspended its charges. Honecker was then exiled to Chile, where he died in May 1994.

Honecker was born in Neunkirchen, Saarland, Germany. He joined the Communist Party in 1929. From 1935 to 1945, he was held in prison by the Nazis. From 1946 to 1955, Honecker served as chairman of an East German Communist youth group called Free German Youth. He was elected to the Volkskammer, the East German legislature, in 1949. During the mid-1950's, he studied Communist theory and practice in the Soviet Union. In 1958, Honecker became a member of the Political Bureau, the governing body of the Communist Party. He served as East German secretary for military and security affairs from 1958 to 1971. In 1976, he was named to the government post of chairman of the council of state. He was forced to resign from this post at the same time that he resigned as general secretary of East Germany's Communist Party.

Honegger, Arthur (1892-1955), was a Swiss-French composer. In the early 1920's, he was associated with *Les Six,* a group of six French composers who rejected the prevailing taste for romanticism and impressionism in music. Honegger developed a highly personal style that featured energetic rhythms. Writing in a style that is clearly tonal most of the time, Honegger occasionally composed passages with *polytonal* and *atonal* harmonies.

Honegger's most popular composition is the short symphonic piece *Pacific 231* (1924), which portrays in rhythm the motion of a locomotive. He wrote many works for the theatre, notably *King David* (1921) and *Joan of Arc at the Stake* (1938). He also composed symphonies, concertos, piano and chamber music, and works for chorus and solo voice. Honegger was born in Le Havre, France.

Honey is the sweet, thick fluid made by bees from flower nectar. Nectar is a thin, watery liquid. Bees sip it from the blossoms and carry it to their hives. Each worker bee has a pouch in its body, called a honey stomach, where the nectar is stored. In the pouch, the sugar and nectar are broken down by a process called *inversion* into two simple sugars, *fructose* and *glucose.* After bees deposit the nectar in the hive, they allow most of the water to evaporate and the liquid thickens. They also add enzymes that enhance the flavour.

Kinds of honey. The flavour and colour of honey are influenced by the kinds of flowers from which the nectar comes. Honey ranges in colour from white to dark amber. Usually the light-coloured honeys have the mildest flavour. The most common honey plants are alfalfa, alsike clover, sweet clover, and white clover.

Most pure honeys *granulate* (develop sugary crystals). Industrial users heat the honey to prevent granulation.

Food value. Honey is an excellent energy food because it contains simple sugars that can be used quickly by the body. It differs chemically from cane sugar, which is also an energy food. Honey contains mineral salts and other materials needed by the body. It is the only form of sugar food that does not need to be refined.

The honey industry. Honey was once sold only in the comb. That is, the little waxy cells that contain the honey were sold along with the liquid. Today, suppliers usually remove the comb and seal the honey in airtight

Bees store nectar in their hives in tiny, six-sided containers called cells, *above.* After it is stored in the cells, the water in the nectar evaporates, and the nectar changes into honey.

containers. This keeps the honey fresh for many months. Commercial producers place the honeycombs in a *honey extractor*. This machine whirls the honeycombs around, forcing the honey out. The honey is then bottled and sold. When honey stands for a long time, the liquid may separate to form hard particles, called *crystals*.

History. Honey was important in ancient times. A jar of honey on the table was once considered a mark of great wealth. In the Bible, the Israelites were promised a "land flowing with milk and honey." The ancient Egyptians are believed to have used honey in embalming.

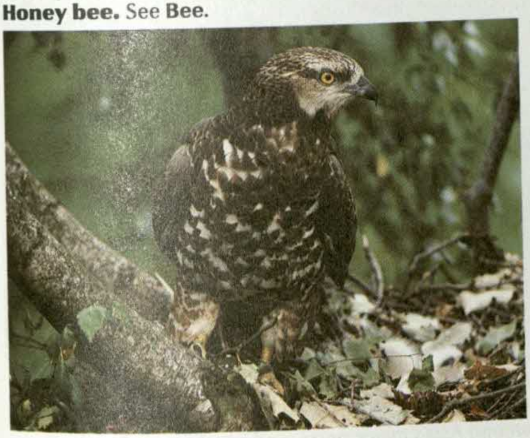
See also **Bee**; **Beeswax**.

Honey ant. See **Ant** (Honey ants; picture).

Honey badger. See **Ratel.**

Honey bear. See **Sloth bear.**

Honey bee. See **Bee.**



The honey buzzard nests in forest areas, and may use the disused nests of crows and buzzards.

Honey buzzard is a European bird of prey. It is more slender than other buzzards of the region, but similar in length (from 50 to 58 centimetres), and with longer, narrower wings. The head is smaller and more pigeonlike. The plumage is mainly dark grey or brown, with lighter undersides. The honey buzzard spends more time on the ground than other buzzards. It walks easily, and runs with its head extended and its body horizontal. It has the habit of raiding wasp and bumble-bee nests to feed on the grubs and adult wasps and bees. The honey buzzard winters in North Africa and the Near East.

Scientific classification. The honey buzzard belongs to the family Accipitridae. It is *Pernis apivorus*.

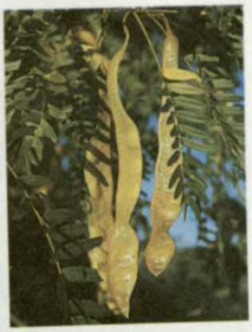
Honey locust is a medium-sized tree with spreading branches and handsome, finely divided leaves. There are 11 species native to Asia, Iran, and North America. The bark of a honey locust is furrowed. In some kinds, stout spines grow on the trunk and branches. The fruit look like long, somewhat flattened and twisted pea pods. They contain a sweetish pulp used as cattle feed. The wood is hard, heavy, and durable. It is used for fuel, posts, railway sleepers, and veneer. Honey locust trees are often grown as shade trees and ornamentals.

Scientific classification. Honey locusts belong to the pea family, Leguminosae (Fabaceae). They make up the genus *Gleditsia*. The common honey locust is *G. triacanthos*.

See also **Locust** (tree).

Honeybee. See **Bee.**

A honey locust, *below*, has a slender trunk and spreading branches. The wood of a honey locust is hard, heavy, and durable. The tree's fruit, *right*, resembles flat and somewhat twisted pea pods.



Honeycomb. See **Bee**, with pictures.

Honeydew melon. See **Muskmelon.**

Honeyeater is the name of a family of about 170 species of land birds. Most honeyeaters live in Australia and New Guinea, but some are found in Hawaii and on other islands in the Pacific Ocean. Two kinds of honeyeaters, called *sugarbirds*, live in South Africa.

Honeyeaters have a long, tube-shaped tongue with brushlike edges. This tongue is especially suited for eating nectar from flowers. When honeyeaters are looking for nectar, they sometimes carry pollen from one plant to another (see **Pollen**). The birds also eat berries, fruit, and insects, but they digest nectar faster. They may get intoxicated and cannot fly if the nectar has been *fermented* (turned into alcohol) by rain and sunlight.

Most honeyeaters are greenish- or greyish-brown with yellow or white markings on their heads. They range from about 10 to 50 centimetres long. Most honeyeaters live in colonies in forests and build cup-shaped nests in trees and bushes. They lay one to four

The honeyeater gets its name from its habit of eating nectar from the blossoms of trees and shrubs. These birds also eat caterpillars, spiders, and berries and other fruit.

eggs at a time. Only the female incubates, but both parents feed the young. Some species can sing well, but most honeyeaters make only harsh, unpleasant noises.

Honeyeaters became almost extinct on the Hawaiian Islands once white people settled there. American and English settlers brought animals that killed these birds. The destruction of forest areas also reduced the number of honeyeaters. Five species once lived in Hawaii. But in the mid-1980's, only one bird of one species, was known to have survived.

Scientific classification. Honeyeaters make up the family Meliphagidae.

Honeysuckle is any one of a family of ornamental shrubs and climbers. Most honeysuckles are evergreens, or nearly so. They grow in temperate regions throughout the world. All have dark green, oval leaves that are usually quite smooth and grow opposite each other in pairs. Sometimes the bases of the leaves are united around the stem. In other plants, the woody stem seems to grow through the leaves.

Honeysuckles usually produce many trumpet-shaped flowers. The blossoms of some are small, but all are quite beautiful. Many are fragrant. The colours vary from white, yellow, pink, and purple to bright scarlet. When the petals drop off, red, yellow, white, black, or blue berries form. Many birds eat these berries and carry the seeds away, distributing the plants widely.

Most honeysuckles are hardy and easy to grow. Gardeners raise the plants either from cuttings or from seeds. Honeysuckles grow compactly and seldom need pruning. Bush honeysuckles are grown as shrubs, and some types grow well in rock gardens. Climbing honeysuckles are often trained to twine over walls or fences.

Various insects bring pollen to the honeysuckles. The white-flowered kinds lure hawk moths at night. The *bush honeysuckle,* with its small yellow blossoms, attracts bees. The *trumpet honeysuckle* has blossoms that are red outside and orange-yellow inside. Hummingbirds like the sweet nectar of these honeysuckle flowers. Some honeysuckles are also called *woodbine.*

Coral honeysuckle

Scientific classification. Honeysuckles belong to the honeysuckle family, Caprifoliaceae. The bush honeysuckle is *Diervilla lonicera.* The trumpet honeysuckle is *Lonicera sempervirens.* Woodbine is *L. periclymenum.* Two species widely used in landscaping are *L. tatarica* and the fragrant *L. fragrantissima.*

See also **Black haw; Elder; Guelder rose.**

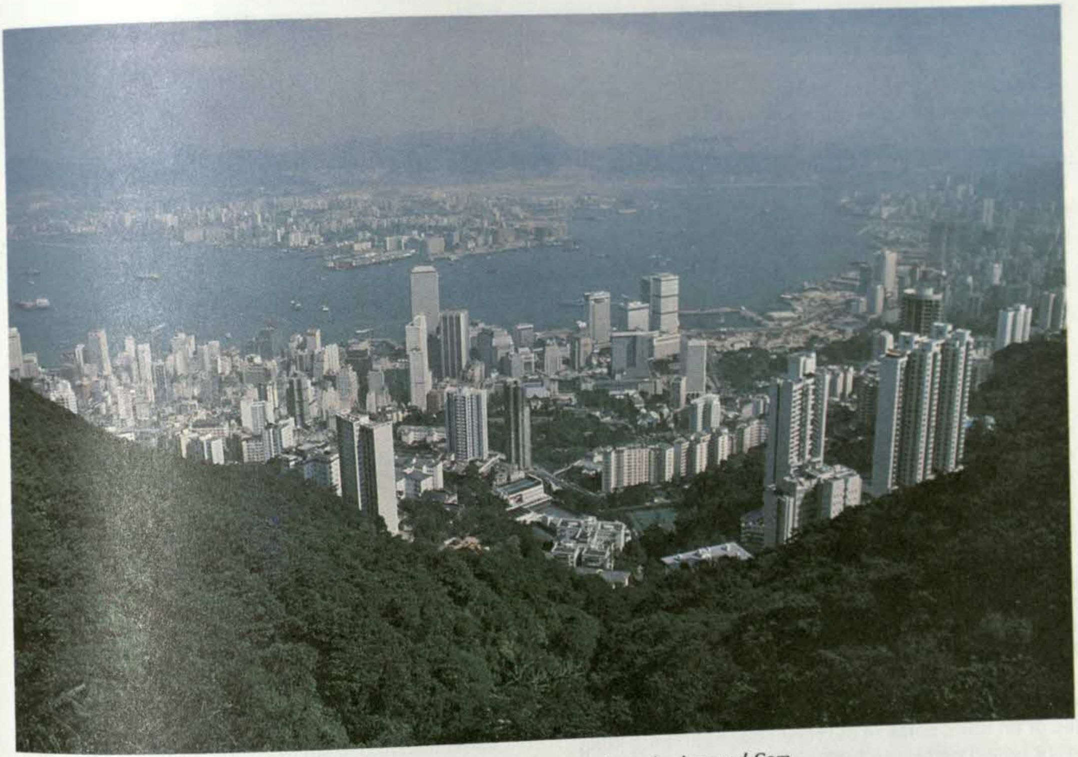
Hong Kong (pop. 5,756,000) is a United Kingdom (UK) dependency on the southern coast of China. For many years, the United Kingdom considered Hong Kong a crown colony. The UK reclassified all its colonies as dependencies in the 1970's, but Hong Kong is still often called a colony. It lies near the mouth of the Zhu Jiang (Pearl River), about 140 kilometres southeast of Guangzhou (also called Canton), China.

Hong Kong is a bustling centre of economic activity and one of the world's most crowded places. It ranks among Asia's major ports, and as a centre of trade, finance, manufacturing, and tourism. Hong Kong has a land area of only about 1,060 square kilometres, but about 6 million people live there. On average, about 5,300 people live on each square kilometre.

Hong Kong consists of a peninsula attached to the mainland of China, and over 235 islands. The mainland area has two sections—the New Territories in the north and the Kowloon Peninsula in the south. The main island, Hong Kong Island, lies to the south of the peninsula.

Most of Hong Kong's economic activity takes place in two urban areas, where most of the people live. The areas are the northern part of Hong Kong Island and the southern part of the mainland. The northern part of Hong Kong Island is sometimes called Hong Kong City. Part of Hong Kong City is the dependency's centre of government and finance. This area is named Victoria, though it is often called the Central District. The urban area on the dependency's mainland is called Kowloon. Victoria is Hong Kong's capital, and Kowloon is the largest urban area. These two areas are separated by Victoria Harbour. The Chinese call this large, beautiful area *hong kong* (fragrant harbour).

All of present-day Hong Kong was part of China from ancient times until the 1800's. The United Kingdom gained control of Hong Kong Island in 1842 and the Kowloon Peninsula in 1860 through treaty agreements with China. In 1898, China leased the New Territories to the UK for 99 years. During the late 1800's and early 1900's, Hong Kong served as a port for UK trade with China. Since the mid-1900's, Hong Kong has grown into



Hong Kong City lies across a harbour from the larger urban area of Kowloon, *background.* Commuters cross the harbour on ferries that leave every few minutes.

a centre of international trade and finance and has also developed many of its own industries. Under a 1984 agreement between China and the UK, control of Hong Kong was scheduled to be transferred to China in 1997.

Almost all the residents of Hong Kong are Chinese. Through the years, millions of people have moved from China to Hong Kong to find jobs. Since the Communist conquest of China, large numbers of Chinese have fled to Hong Kong to escape Communist rule.

Government

A governor heads the government of Hong Kong. The UK monarch appoints the governor to a term of unspecified length. A 15-member executive council helps the governor carry out government operations. A legislative council, which has about 60 members, makes Hong Kong's laws. All the members of the executive council and all except 15 members of the legislative council are nominated by the governor and appointed by the UK monarch. The 15 other members of the legislative council are elected by the people. Members of the executive council serve five-year terms, and legislative council members serve four years. British officials hold the governorship and most other top posts in the government. Chinese citizens of Hong Kong serve in many of the lower offices.

Although the UK controls the government, Hong Kong is basically Chinese in character. The UK tries to limit its role in the dependency. The government's functions include maintaining law and order and providing roads and sanitation facilities. The government works to provide housing for the needy, free education for all children, and care for the elderly. It also promotes Hong Kong's economy but tries as much as possible to avoid interfering in business activities and the lives of the people.

People

Population and ancestry. Hong Kong has about 6 million people, of whom about 90 per cent are Chinese. Most are immigrants from southern China or descendants of immigrants from that region. The relatively few non-Chinese residents of Hong Kong include people from Australia, India, Japan, the United Kingdom, the United States, and Vietnam.

Languages. Hong Kong has two official languages, English and Chinese. English was the only official language until 1974, but most of Hong Kong's Chinese people do not speak or understand it well, if at all. The majority of them speak Yue, the Cantonese dialect of Chinese. As a result, the government made Chinese an official language.

Way of life. About 90 per cent of Hong Kong's people live in urban areas. Many work in factories, and others are employed by the government or the shipping industry.

Most of the urban people live in Hong Kong City and Kowloon. Hong Kong's other urban settlements include Tsuen Wan, Tuen Mun, and Sha Tin.

People in rural areas of Hong Kong live in small farming villages and raise crops and livestock. Some farmers still plant and harvest crops by hand or with hand tools.

But new farming methods and machinery have enabled many to increase their production.

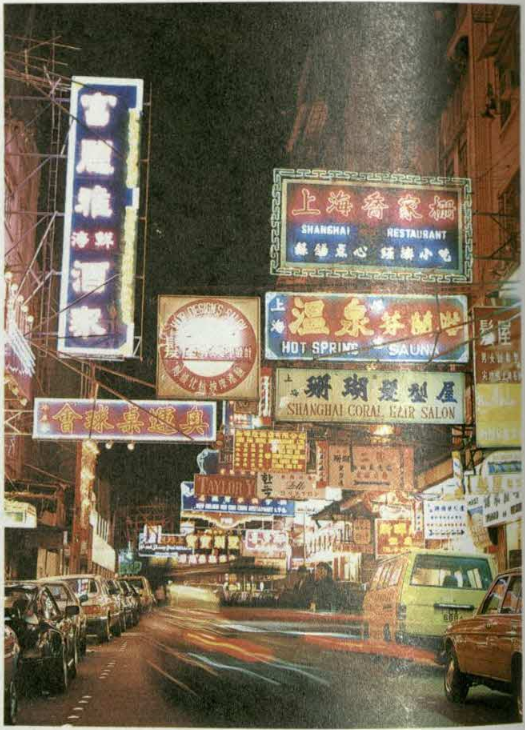
The people of Hong Kong eat large amounts of fresh vegetables, fish, and rice, and some poultry and pork. Many of them wear the same type of clothing as that worn in Western countries. Others wear Chinese-style clothing, such as dark-coloured trousers and shirts, and long robes. The major religions in Hong Kong are Buddhism and Taoism. Small groups of Christians, Hindus, Jews, and Muslims also live there.

Housing in Hong Kong's urban areas varies sharply. Most wealthy people live in luxury apartment buildings, and some live in beautiful houses with gardens. Large numbers of middle- and low-income people occupy crowded high-rise flats, which stand close together. In many cases, several poor families share one or two small rooms. Large numbers of refugees from China once lived in wood and tin shacks, which stood on hillsides, under bridges, and even on the roofs of buildings. Thousands of families also made their homes on boats in harbours. Some such dwellings still exist, but there are far fewer than in the past.

Hong Kong's government began a public housing programme in the mid-1950's to improve housing. Since then, the government has erected low-rent flats for more than 2 million people. Most of these flats are in huge housing complexes called *resettlement estates.*

The majority of Hong Kong's rural people live in one- or two-storey houses made of brick or stone. Most have tile or tin roofs. Some of the rural villages in Hong Kong were settled more than 1,000 years ago.

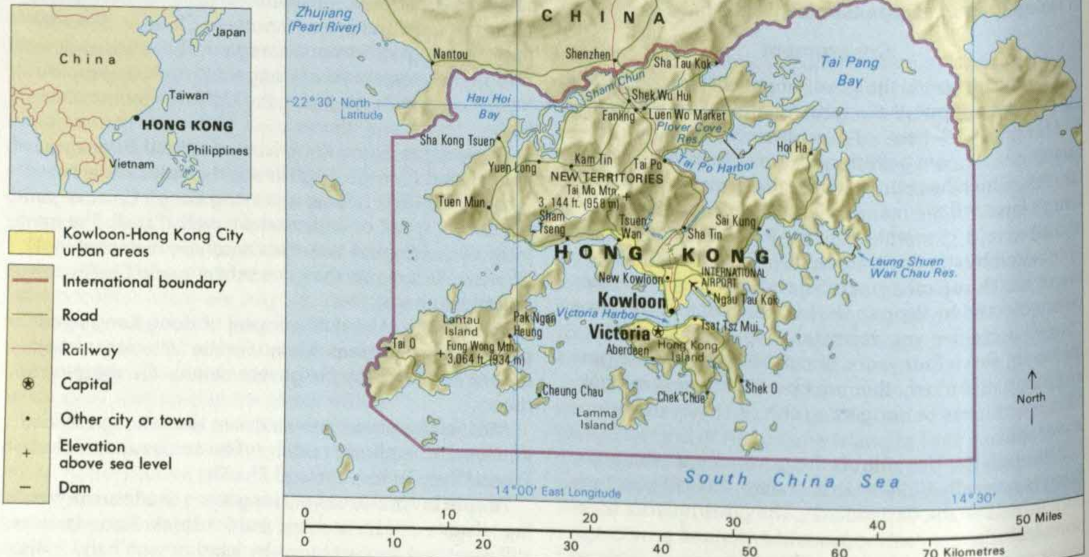
Education. All children in Hong Kong are required by law to go to school for nine years—six years at primary school and three at secondary school. The government supports the state school system, in which classes are taught in Chinese. A few private schools conduct classes in English. About 75 per cent of the people can read and write.



Kowloon at night is a major tourist attraction. The shops stay open until late at night.

Hong Kong has three universities and four teacher training colleges. The University of Hong Kong, founded in 1911, has about 9,000 students. The Chinese University of Hong Kong, founded in 1963, has about 7,000 students. A further 1,000 students attend the Hong Kong University of Science and Technology, which was founded in 1988.

Hong Kong



Street markets in Hong Kong sell clothing, jewellery, textiles, and a wide variety of other items. They serve both Hong Kong residents and tourists. Over 2 million tourists visit Hong Kong each year.

Hong Kong City and Kowloon

Hong Kong City and Kowloon are the main centres of trade, finance, industry, and tourism in Hong Kong. Many small shops, open markets, and high-rise buildings line the narrow streets of these crowded areas.

Hong Kong City and Kowloon lie on opposite sides of Victoria Harbour. Every day, thousands of people cross the harbour on ferries to go to work or to shop. About 85,000 motor vehicles travel daily between the Kowloon Peninsula and Hong Kong Island by means of a tunnel under the harbour. An underground railway links Hong Kong City and Kowloon.

Hong Kong City is an urban area with a population of about 1 million. The Victoria part of the area is the seat of government and the financial centre of Hong Kong. Government buildings and banks and other financial establishments are in Victoria. Local residents own some of the banks. Others are branches of large banks of China, Japan, the United Kingdom, the United States, and other countries. High-rise commercial buildings and fashionable shops and hotels stand along the waterfront of Hong Kong City.

A beautiful mountain called Victoria Peak rises west of Victoria. Luxury apartment buildings and attractive houses line the steep sides of the mountain. A railway transports passengers between Victoria and the top of the mountain. Many people live in crowded tenements in the Wanchai district of Hong Kong City, east of Victoria.

Kowloon is larger and more crowded than Hong Kong City. About 2,400,000 people live in this urban area. It includes an old section and a newer area, called New Kowloon. The old section of Kowloon, which lies along Victoria Harbour, has a population of about 750,000. New Kowloon lies north of the old section and has a population of about 1½ million.

The old section has many shops, hotels, and restaurants. Tourists flock to stores along Nathan Road in the centre of Kowloon to buy cameras, jewellery, made-to-measure clothing, and other products. Many merchants sell their goods in the streets or at open-air market places. The market places offer such items as fresh vegetables, fish and poultry, and household goods. Many resettlement estates and factories are in New Kowloon.

Most visitors to Hong Kong arrive first at Kai Tak International Airport in Kowloon. Passenger ships dock at Kowloon's Ocean Terminal, one of the largest piers in Asia. A railway runs through the New Territories and connects Kowloon with Guangzhou, China. Ferries also provide transportation between Kowloon and Guangzhou.

Land and climate

Hong Kong covers a total area of 2,916 square kilometres. But only 1,060 square kilometres of the total area is land.

The land. Rugged mountains and rolling hills cover much of Hong Kong. Some mountains in the New Territories rise more than 910 metres above sea level. Victoria Peak, on Hong Kong Island, is 554 metres high.

The rocky, indented coastlines of Hong Kong's islands and mainland provide many small harbours for fishing villages. Parts of Victoria Harbour have been filled in with earth to create new land. Kai Tak International Airport and many buildings are on land reclaimed from the harbour.

Barren mountains separate the business districts of the Kowloon Peninsula from farmland in the New Territories. Only about 10 per cent of the land in Hong Kong is suitable for farming. Throughout the New Territories, rice paddies and vegetable and flower fields lie crowded between areas of poor vegetation and rocky hillsides. A small river called the Sham Chun forms the border between Hong Kong and China.

Climate. Hong Kong has a semitropical climate. Summers are hot and humid, with temperatures reaching 35° C or higher. Hong Kong receives about 225 centimetres of rainfall yearly. More than 75 per cent of the rain falls in summer and causes flooding and mudslides.

Winters in Hong Kong are cool and dry, and the temperature seldom falls below 4° C. Insufficient rainfall during the winter and other factors cause water shortages, and so Hong Kong buys millions of litres of water from China every year.

Economy

Hong Kong has one of the strongest and most varied economies in Asia. It is a centre of international trade, finance, and tourism. About half the people of Hong Kong work for manufacturing firms, and about 40 per cent have jobs in commerce or in the government. Less than 3 per cent of Hong Kong's people make their living by farming or fishing.

Hong Kong is a *free port*–that is, it collects no import duties on goods brought in from elsewhere. As a result, many products can be bought and sold more cheaply in Hong Kong than in most other parts of the world. Business firms of many countries operate in Hong Kong.

More than 100 banks and 4 stock exchanges are in Hong Kong. The banks finance housing, manufacturing, and trade there and in other parts of the world. Over 2 million tourists visit Hong Kong annually. The money they spend greatly aids the economy.

Since the early 1950's, Hong Kong has become an important industrial centre. It has more than 38,000 factories, which make a wide variety of products. Almost all the manufactured products are exported, and textiles and clothing account for about half the exports. Hong Kong also exports large quantities of electronic equipment, metal goods, and plastic products. Hong Kong exports its products chiefly to, in order of importance, the United States, Germany, the United Kingdom, and Japan. Hong Kong imports large quantities of food, machinery, steel, and iron and other raw materials. It imports these products mainly from Japan, China, the United States, and Taiwan.

Agriculture is a minor economic activity in Hong Kong, and the dependency must import large amounts of food to meet its needs. Farm products include vegetables, poultry, and rice. Fishing fleets from Hong Kong catch eels, sardines, and other seafood.

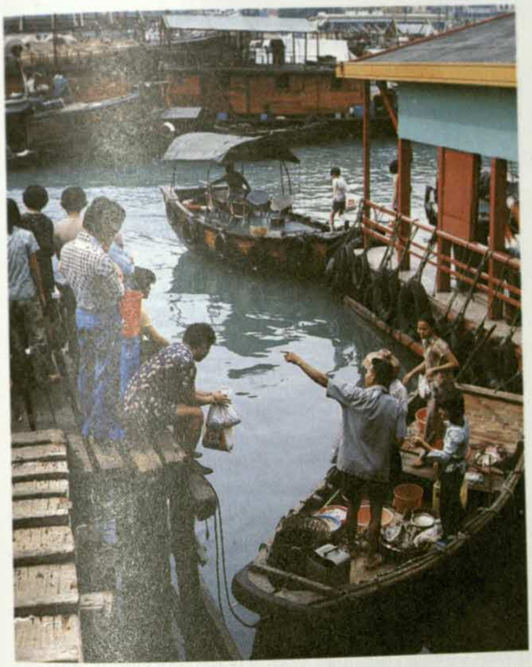
History

Early days. Since ancient times, people have lived in what is now Hong Kong. The area came under Chinese control about 220 B.C. Until the A.D. 1800's, it consisted of a few small fishing and farming villages. Pirates used Hong Kong as a land base.

United Kingdom control. During the 1800's, the Chinese government tried to stop UK merchants from smuggling opium into China. In 1839, this issue led to the Opium War between China and the UK. The UK won the war and received the island of Hong Kong as part of the Treaty of Nanjing in 1842. In 1860, the UK gained control of the Kowloon Peninsula as part of a settlement of further trade disputes with China. In 1898, China leased the New Territories to the UK for 99 years.

Population growth. In 1842, Hong Kong had only about 5,000 people. Its dramatic population growth resulted largely from five major waves of immigration. The first immigration wave began in 1911, during a movement by Chinese revolutionaries that overthrew China's Manchu dynasty and established the Republic of China.

The Hong Kong water front is always busy. Passenger ships dock at the Ocean Terminal, ferries cross to the islands, and many people live on houseboats in the harbours.



Hong Kong shopkeepers sell fish from a *sampan* (small boat). Fish with vegetables and rice make up a large part of the diet of the people of Hong Kong.

Many Chinese fled to Hong Kong and, by 1915, the population had increased to about 500,000.

The second wave of immigration began in 1937, after Japan invaded China. Large numbers of Chinese again fled to Hong Kong. By 1939, Hong Kong's population had reached 1,600,000. Japanese troops occupied Hong Kong from 1941 to 1945, during World War II. The population dropped to 600,000 in that period, mainly because many Chinese returned to China.

The third wave of immigration began in 1949, when Communists took control of China. This immigration soon pushed Hong Kong's population up to about 2 million. In 1962, a threat of widespread starvation in China set off a fourth wave of immigration into Hong Kong. By 1965, the number of people in Hong Kong had soared to more than 3 million.

The population grew steadily during the 1960's and 1970's. In addition, a fifth wave of immigration occurred in the late 1970's, when thousands of Vietnamese fled to Hong Kong. The government offered inducements to the refugees to return to Vietnam and, in late 1989, began a programme of repatriation. Today, the population of Hong Kong is about 6 million.

Relations with China. The Chinese Communist government never formally recognized the UK's control of Hong Kong. But it did not actively oppose UK rule, probably because Hong Kong has great value for the Chinese economy. China earns much income by selling food, water, raw materials, and manufactured products to Hong Kong. The Chinese government also owns many banks, department stores, and hotels in Hong Kong. In the late 1960's, some of Hong Kong's Chinese residents held violent demonstrations against British control. But the Chinese government did not try to take control of Hong Kong, and the riots ended.

In the late 1970's, China began to invest large sums of money in Hong Kong to help strengthen the Chinese economy. In 1984, after two years of negotiations, China and the United Kingdom worked out an agreement regarding the transfer of Hong Kong from UK control to Chinese rule when the UK's lease of the New Territories expires in 1997. Under the agreement, Hong Kong will become a special administrative region of China with a high degree of control over its government affairs except in foreign policy and defence. Hong Kong will also be allowed to keep its capitalistic economy within the socialist system of China. These arrangements are to be in effect for 50 years after 1997.

Related articles in ***World Book*** include:

Asia (picture: Floating homes)
China (The age of empire [Clash with Western powers])
Flag (picture: Flags of Asia and the Pacific)
Macao
Patten, Christopher
Police (Police around the world)
Stock exchange

Outline

- **I. Government**
- **II. People**
  - A. Population and ancestry
  - B. Languages
  - C. Way of life
  - D. Housing
  - E. Education
- **III. Hong Kong City and Kowloon**
  - A. Hong Kong City
  - B. Kowloon
- **IV. Land and climate**
  - A. Land
  - B. Climate
- **V. Economy**
- **VI. History**

Questions

What is the average number of people living in each square kilometre of Hong Kong?
How did the UK gain control of Hong Kong? When?
What are the main functions of the Hong Kong government?
What is a *free port?*
Only 3 per cent of Hong Kong's people are fishermen or farmers. How does the dependency get its food?
When does UK rule in Hong Kong come to an end?
Why did China invest large sums of money in Hong Kong?
When was the Chinese University founded?
What are the manufactured goods that Hong Kong exports?
How many banks and stock exchanges are there in Hong Kong?

Hongi Hika (1777-1828), a famous Maori chief and warrior, was head of the Ngapuhi tribe in the early 1800's. Under his leadership, the warriors of his tribe won many battles against other tribes who lived in the North Island of New Zealand.

In 1814, Hongi visited Australia, where he met the missionary Samuel Marsden (see **Marsden, Samuel**). Hongi agreed to protect missionaries sent by Marsden to New Zealand. One of these missionaries, Thomas Kendall, later took Hongi and another chief to the United Kingdom to help compile a dictionary of the Maori language. In the UK, many people gave Hongi gifts. He later sold these gifts in Australia to buy guns for his tribe.

For the next seven years, the heavily armed Ngapuhi tribe waged a series of battles against other tribes in the Hokianga, Thames, Auckland, Waikato, and Rotorua areas of the North Island. Most of these tribes lived in constant fear of Hongi. During fighting in dense bush at Whangaroa, on the northwestern coast, Hongi was shot and died from his wounds.

Honiara (pop. 30,499), is the capital and largest community of Solomon Islands, an island country in the southwestern Pacific Ocean. Honiara, a small town, is on the north coast of Guadalcanal Island. For location, see **Solomon Islands** (map).

The town lies on two sides of Point Cruz, a harbour that serves both small and seagoing ships. Honiara has several prominent buildings, including Government House and an Anglican church. Many of the people live in houses on ridges near the centre of the town. Honiara was built after World War II ended in 1945. The town stands on a site that Japan, and later the United States, used as a military base during the war.

Honolulu is the capital, largest city, and chief port of Hawaii. The city, often called the *Crossroads of the Pacific,* is a stopping point for ships and planes crossing the ocean. It is about 3,860 kilometres from San Francisco and 6,120 kilometres from Tokyo.

In 1794, Captain William Brown of England sailed into what is now Honolulu Harbor. The harbour provided shelter, and other ships began to stop there. Honolulu soon became an important trading centre. *Honolulu* is a Hawaiian word meaning *sheltered bay.*

People. About a quarter of Honolulu's people have Japanese ancestry, and about another quarter of the people are white. About a sixth of the people are Hawaiian or part Hawaiian. Other groups include those of Chinese, Filipino, Korean, Puerto Rican, or Samoan descent. More than a quarter of the people have mixed ancestry. American military personnel and their families make up about 15 per cent of Honolulu's population.

Economy. Tourism is Honolulu's largest source of income. Visitors enjoy the beautiful scenery, recreation areas, and mild climate. Honolulu's economy also depends on military activities. The city is the centre of United States military operations in the Pacific region.

Honolulu has approximately 500 manufacturing companies. The city's leading industry is food processing, which includes the processing of pineapples and sugar cane. Other manufacturing industries in Honolulu produce cement, clothing, furniture, glass products, oil products, plastics, and timber.

History. During the 1800's, Honolulu flourished first as a centre for the sandalwood trade and later as the major Pacific whaling base. During the late 1800's, farmers began to raise large crops of pineapples and sugar cane. Thousands of labourers from China, Japan, and other countries came to work in the pineapple and sugar fields. Many others found work in the factories.

The city became the permanent capital of Hawaii in 1845, and it remained the capital when Hawaii became a territory of the United States in 1900.

Honorius I (? -638) was elected pope in 625. He patterned himself after Pope Saint Gregory I, who died in 604. Like Gregory, he turned his mansion in Rome into a monastery. Honorius rebuilt an aqueduct, remodelled Roman churches, encouraged missionary work in Britain, and negotiated peace with the Lombard tribe (see **Lombards**).

Honorius tried to settle a controversy over the nature of Jesus Christ. He suggested a solution that was rejected almost everywhere in the West and in many places in the East. In 681—43 years after his death—the third Council of Constantinople condemned Honorius' view and branded him a heretic. Honorius was born into a wealthy aristocratic family in the Campania region of southern Italy.

Honorius III (? -1227) was elected pope in 1216. After his election, he carried out the plans of Innocent III, the previous pope, for the Fifth Crusade to the Holy Land. He encouraged the Holy Roman Emperor Frederick II to participate in the expedition, but because of weak leadership and Frederick's absence, the crusade failed (see **Crusades**). In 1218, Honorius began a crusade against the Muslim Moors in Spain. He also continued the crusade started by Innocent III against the Albigenses, a group of heretics in southern France.

Honorius approved the Dominican religious order in 1216 and the *rule* (programme of life) for the Franciscan order in 1223. In 1226, Honorius ordered the first official compilation of *canon* (church) law. Honorius was born in Rome. His family name was Cencio.

Honours and awards in the United Kingdom are formal tokens of the respect that the state feels is due to people who have earned public recognition for their brave deeds, their long service, or their valuable work.

Honours lists are issued twice a year in special supplements to *The London Gazette* (see **London Gazette**). The New Year's Honours List is published on or about December 31, and the Birthday Honours List on the queen's official birthday, which is usually celebrated early in June. The Dissolution Honours List is issued when Parliament is dissolved before a general election.

Various official bodies recommend to the prime minister the names of people who should be honoured. Four orders are the personal awards of the queen. They are the Order of the Garter, the Order of the Thistle, the Order of Merit, and the Royal Victorian Order.

Awards for bravery are published separately, outside the regular honours lists.

Investitures are the ceremonies at which the Lord Chamberlain presents to the queen each person to be honoured. The queen pins the decoration on the person's coat.

Order of precedence. There is a strict order of precedence in which orders, decorations, and medals should be worn. The full list is long and complicated. First come the Victoria Cross and the George Cross, the highest awards for bravery. Next come the *Orders*—the Garter, the Thistle, the Bath, Merit, St. Michael and St. George, the Royal Victorian, and the British Empire, and the Order of the Companions of Honour and the Distinguished Service Order. Three Orders of knighthood are no longer awarded. The Order of St. Patrick was an Irish Order created in 1818. No knights have been made since Ireland's independence in 1921. The Orders of the Star of India and the Indian Empire ceased to be awarded after India and Pakistan became independent in 1947.

Decorations ranking next are the Royal Red Cross, the Distinguished Service Cross, the Military Cross, the Distinguished Flying Cross, and the Air Force Cross. They are followed by the Order of St. John and the Albert Medal for life-saving.

Medals for gallantry and distinguished service total more than 20. They include the Distinguished Conduct Medal, the Conspicuous Gallantry Medal, the George Medal, the Police Medal for Gallantry, and the British Empire Medal.

War medals include all medals and stars for service during wars and campaigns. An example is the 1939-1945 Star for service during World War II. War medals are worn in order of their date, the most recent last.

Commemoration medals were issued to mark the coronations of King Edward VII, King George V, King George VI, and Queen Elizabeth II, the Golden and Diamond Jubilees of Queen Victoria, and the Silver Jubilees of King George V and Queen Elizabeth II.

Medals for long and efficient service include the medals for members of the Royal Navy, the Army, and the Royal Air Force; Meritorious Service medals; medals for police officers and firefighters; and medals for members of the voluntary medical services.

See also **Knights and knighthood; Peer of the realm.**

Honshu. See **Japan** (Land).

Hoo Ah Kay. See **Whampoa.**

Hooch, Pieter de. See **De Hooch, Pieter.**

Hood, a ship. See **Bismarck.**

Hood, John Bell (1831-1879), was an American Confederate general. He was a brigade and division commander in General Robert E. Lee's army during the American Civil War (1861-1865).

Hood commanded a corps in the Army of Tennessee and took command of that army with the rank of general in 1864. He fought General William T. Sherman at Atlanta but had to abandon the city. Hood began a campaign in Tennessee but was beaten at Nashville.

Hood was born in Kentucky. He graduated from the U.S. Military Academy.

See also **Civil War, American.**

Hood, Robin. See **Robin Hood.**

Hood, Samuel (1724-1816), Viscount Hood, was a British admiral. He outmanoeuvred the French admiral De Grasse in two brilliant actions in the West Indies in 1782 and took part in the victory off Dominica in the same year. In 1793, during the war with France, Hood became commander-in-chief of the Mediterranean fleet. He captured Toulon, but was forced to withdraw. In 1794, he captured and held Corsica.

Samuel Hood was born in Thorncombe, Dorset, England. He was created Viscount Hood and became governor of Greenwich in 1796.

Hood, Thomas (1799-1845), was a British poet and humorist. His best poems, "The Song of the Shirt" and "The Bridge of Sighs," expressed love and pity for suffering humanity. Hood was born in London and trained as an engraver. Hood's humorous writing is full of the use of the pun. He once said, "So that I may earn my livelihood, I have to be a lively Hood."

Hoof is a hard growth on the feet of mammals called *ungulates*. Ungulates include pigs, zebras, horses, and the horned animals. A hoof is made of horn, a substance developed from the *epidermis* (outer layer of skin). The hoof differs from a nail or claw because it is blunt and it encases the toe or foot. Hoofs developed from the animals' toes. The ungulates are divided into those with even and odd numbers of toes.

The horse's hoof developed from a single toe. It almost completely circles the bottom of the foot. Asses and zebras also have single toes. The even-toed animals never have more than four toes. Usually, the two middle toes form a *cleft* (divided) hoof. This group includes deer, antelope, sheep, goats, cattle, pigs, and the hippopotamus. Hoofs give the animal a firm footing and protect its feet. Some animals, such as the deer, can use their hoofs to defend themselves.

See also **Animal** (picture: Kinds of feet); **Horn; Ungulate.**

Hoof-and-mouth disease. See **Foot-and-mouth disease.**

Hooghly River, in West Bengal, India, is one of the channels through which the Ganges River flows into the Bay of Bengal. The Hooghly is a dying distributary, because the main flow of water has shifted to more easterly channels. The Hooghly flows southward for about 240 kilometres. Large ships can sail up the river as far as Calcutta, 138 kilometres from the sea.

See also **Bengal.**

Hook. See **Fishing** (Hooks).

Hookah. See **Pipe** (tobacco).

Hooke, Robert (1635-1703), an English experimental scientist, stated the currently accepted theory of elasticity in *Hooke's law*. This law states that the amount an elastic body bends or stretches out of shape (strain) is in direct proportion to the force (stress) acting on it. The law applies as long as the body is still elastic. Increased stress beyond this elastic limit will change the shape of the body permanently. Hooke also built the first Gregorian telescope, an early reflecting telescope. Using an early microscope, he discovered plant cells. In addition, he stated the law of inverse squares (see **Light** [Measuring light]). Hooke's recognition of the similarity between the motion of a vibrating spring and that of a swinging pendulum led him to develop a balance spring for regulating watches.

Hooke had varied interests and often left experiments unfinished. He recognized aspects of the principle of the law of gravitation before Sir Isaac Newton. But Hooke lacked the mathematical skills and the diligence to demonstrate the theory.

See also **Cell** (Cell research).

Hooked rug. See **Rugs and carpets** (Other methods).

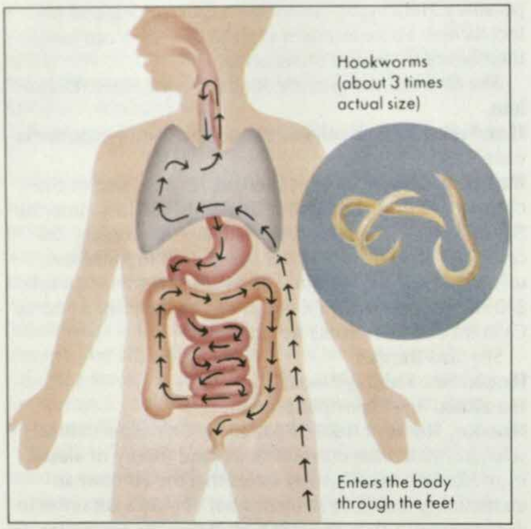
Hooker, Richard (1554-1600), was an English scholar, theologian, and clergyman. His main work, *Of the Laws of Ecclesiastical Polity,* was a defence of the Church of England against arguments set forth by both Puritan preachers and Roman Catholics. He published the first four books of this work in 1593 and a fifth book in 1597. Three final books were published after his death.

Hooker was born in Heavitree, near Exeter, Devon. He was educated at Corpus Christi College, Oxford. In 1585, he became Master of the Temple, then one of the Inns of Court. But after a heated theological dispute with a Puritan, Walter Travers, Hooker gave up the post.

Hookworm is a small roundworm that enters the bodies of human beings and some animals through the skin. Hookworms live as *parasites* in the intestines, sucking up blood and tissue fluids.

Hookworms can cause *anaemia* (a shortage of red blood cells). They harm children more than adults. The child's abdomen and legs may swell, and the child may become dull and listless. Certain hookworms attack animals, including cats and dogs. These hookworms can cause an itchy, red patch on human skin which is called *creeping eruption.*

Hookworm eggs pass out of the *host* (body in which the worm lives) with the body waste and hatch in moist,



The path of a hookworm
A hookworm usually enters the body through the skin. In the body, it enters the bloodstream and is carried into the lungs. It then passes into the throat and is swallowed into the intestines.

warm soil. The *larvae* (young worms) come to the surface of the soil. They burrow into the bare skin of animals that touch them. A person walking barefoot may pick up the worm in this way. A person may also become infected with the worms by swallowing contaminated food or water.

Once in the body, a hookworm larva enters the bloodstream and is carried to the lungs. It burrows into air channels there, passes into the throat, and is swallowed into the intestine. When hookworms reach the intestine, they become adults. Serious infections occur when more than 100 hookworms are in the intestine.

Hookworm eggs and larvae can live outside of the host's body only in warm, moist places. For this reason, hookworm disease is commonly found in tropical and subtropical countries.

Improving conditions of sanitation have reduced the amount of infection by hookworms. Medical treatment with drugs is also used today. Recovery is speeded by eating foods high in protein, vitamins, and iron.

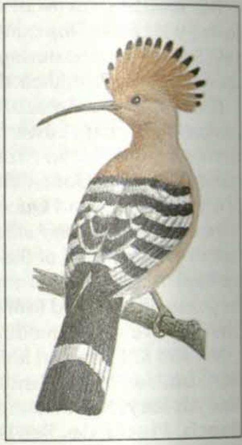
Scientific classification. Hookworms belong to the family Ancylostomidae of the roundworm class Nematoda of the phylum Aschelminthes. The two kinds of hookworms that attack people are *Necator americanus* and *Ancylostoma duodenale.*

See also **Roundworm.**

Hoop pine, also called *colonial pine* or *Moreton Bay pine,* is among the largest of the few species of Australian pines, reaching up to 60 metres. They grow on the south coast of Queensland and the north coast of New South Wales. These pines are used for joinery, furniture, flooring, shelving, plywoods, and veneers.

Scientific classification. Hoop pines belong to the family Coniferae. They are *Araucaria cunninghamii.*

Hoopoe is a bird with a showy crest of feathers on its head and black and white bars on its wings and tail. The hoopoe is about the size of a large thrush. It lives in the warmer regions of Europe, Asia, and Africa.



Hoopoe

Hoopoes nest in holes in trees, walls, and rocks. The female lays five to seven white eggs. The male feeds the female while she *incubates* (sits on and warms) the eggs. Hoopoes eat insects and spend much time on the ground searching for food. When threatened by other animals, such as hawks, hoopoes flatten themselves on the ground with their wings and tail spread and bill pointed upward. When attacked, they may release a foul-smelling fluid from the preen glands.

Scientific classification. The hoopoe makes up the family Upupidae. It is *Upupa epops.*

Hoosier Poet. See Riley, James Whitcomb.

Hoover, Herbert Clark (1874-1964), was president of the United States from 1929 to 1933. He entered the White House at a time when there was great prosperity in the United States. But, seven months later, the stock market crashed and the Great Depression began.

Early life. Hoover was born in West Branch, Iowa, U.S.A., on Aug. 10, 1874. He graduated from Stanford University in 1895. In 1898, Hoover became chief engineer for the Chinese Imperial Bureau of Mines. The Chinese government discontinued its Bureau of Mines after the Boxer Rebellion in 1900, and Hoover went to London (see **Boxer Rebellion**).

Food administrator. Hoover was in London in 1914, when World War I began. From October 1914 to April 1917, Hoover organized food relief for the Belgian people. The United States entered the war in April 1917. Hoover became head of the U.S. Food Administration, supervising the production and distribution of food.

In 1921, Hoover became secretary of commerce. He held that office under presidents Harding and Coolidge.

The Republican Party nominated Hoover for president in 1928, to run against Governor Alfred E. Smith of New York. Hoover won the election.

Hoover's administration (1929-1933). The U.S. economy was weakened by widespread buying on credit. Thousands of people had borrowed money to buy stocks. Stock prices soared. Then, in October 1929, the stock market crashed. The Great Depression had begun.

At first, Hoover was reluctant to interfere, but the economy continued to grow worse. By 1932, more than 12 million Americans were out of work. Factories closed and many banks failed. Thousands of people lost their homes because they could not keep up their mortgage payments. Many families lived in clumps of shacks that were derisively called *Hoovervilles.*

Hoover decided to use the power of the federal government to reduce economic stress. In 1932, at his request, Congress passed several laws enabling the government to help business, and provide credit for home owners and farmers.

In foreign affairs, Hoover guided the United States toward cooperation with other nations. In 1931, Japanese forces invaded Manchuria. China protested to the League of Nations. Hoover declared that the United States would not recognize territorial gains made in violation of the Kellogg-Briand Peace Pact (see **Kellogg-Briand Peace Pact**).

The Republicans renominated Hoover for president in 1932. The Democrats nominated Governor Franklin D. Roosevelt. Roosevelt was elected president.

Hoover died on October 20, 1964, at the age of 90.

See also Great **Depression.**

Hoover, J. Edgar (1895-1972), served as director of the United States Federal Bureau of Investigation (FBI) for 48 years. He held the office from 1924 until his death. Hoover built the FBI into one of the world's outstanding law-enforcement agencies. But a congressional investigation after his death raised questions about some of his actions.

The Bureau of Investigation, which received its present name in 1935, was corrupt and disorganized when Hoover became director. Hoover reformed the agency, largely by appointing people for their ability and promoting them for good performance. He established the world's largest fingerprint file, a crime laboratory, and a training academy.

In 1975, congressional investigators disclosed that Hoover had abused his power a number of times. For example, he tried to win favour with several presidents by gathering scandal about some of their opponents. Under Hoover, the FBI also violated the civil rights of many critics of government policies.

Hoover was born in Washington, D.C. In 1917, he graduated from the George Washington University law school and joined the U.S. Department of Justice.

Hoover Dam is one of the highest concrete dams in the world. It stands in the Black Canyon of the Colorado River, Arizona, United States. The dam is part of the Boulder Canyon Project. The project consists of a dam, a hydroelectric power plant, and a reservoir. It controls floods of the Colorado River and supplies domestic and irrigation water and electric power for a large area of the Pacific Southwest.

Hoover Dam is 221 metres high and 379 metres long. Lifts descend the equivalent of 44 storeys into the dam and still do not reach its base. The concrete base is 200 metres thick.

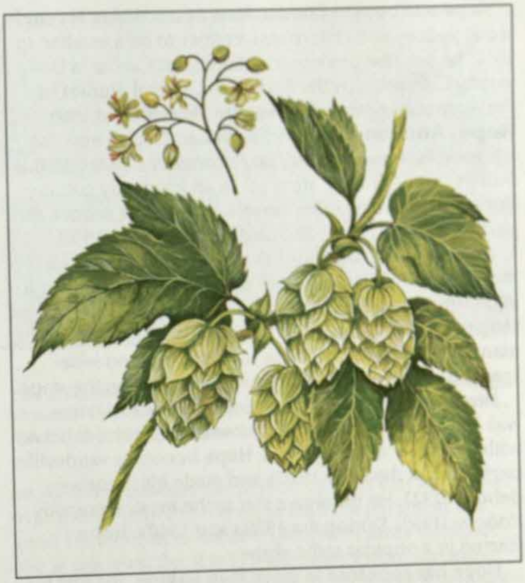
Lake Mead, the dam reservoir, is one of the world's largest artificially created bodies of water. It is about 185 kilometres long and 180 metres deep. The reservoir can store about 36,702,300,000 cubic metres of water.

Hoover Dam was completed in 1936. The dam was named *Hoover Dam* to honour President Hoover.

Hop is a vine grown for its papery, yellowish-green flowers, which are used in brewing beer. The flowers, also called *hops,* grow in conelike clusters that measure from 2.5 to 10 centimetres in length. The petals have tiny glands that contain various oils and *resins* (sticky substances). These materials prevent the growth of certain bacteria in beer and give the beverage its bitter taste.

Hop vines may grow as long as 8 metres in a single growing season. The vines die in the autumn. But the *rhizomes* (underground stems) of the plants continue to live, and they produce new vines the next spring.

Hops grow in a wide range of climates and soils. The plant is grown in Australia, Germany, Japan, New Zealand, South Africa, South America, the United Kingdom, and the United States.



Hops produce male and female flowers on different plants. The female flowers in the lower illustration are used to brew beer.

Growers plant hop rhizomes in mounds 1.5 to 2.5 metres apart. The vines are supported with poles or trellises to keep them from spreading on the ground. Hops are harvested in late summer or early autumn. Workers cut the vines by hand and place them in picking machines that separate the hops from the vines. The hops are then cleaned, dried in ovens, and pressed into bales for shipment or storage.

Scientific classification. Hops belong to the mulberry family, Moraceae. The European hop is *Humulus lupulus.* The Japanese hop is *H. scandens.*

See also **Brewing** (Boiling).

Hope, Alec Derwent (1907-), one of Australia's most distinguished writers, published several books of poetry, including *The Wandering Islands* (1955), *Collected Poems* (1966), and the satirical *Dunciad Minor* (1970). His works of criticism include *The Cave and the Spring* (1965) and *Native Companions* (1974).

Hope wrote entirely in traditional verse forms, and completely mastered every verse form he used. He avoided experimental verse, which preoccupied many of his contemporaries. He was one of the few Australian poets to use satire as a means of expression.

The first poems in *The Wandering Islands* clearly illustrate his theme that all endeavour must end in frustration. This theme is most clearly expressed in the poem "The Death of the Bird," in which the bird follows her biological pattern until she dies.

Hope's later poems express his conviction that poetry can regenerate an individual—supply a spiritual need in a material world—and establish some communication between isolated individuals. One of his poems on this creative spirit is "Pyramis, or The House of Ascent." In it, the poet's creative impulse is compared to that of the ancient Egyptians who built indestructible pyramids.

Hope was born in Cooma, New South Wales. He studied at Sydney and Oxford universities to be a teacher. In 1951, he became professor of English at Canberra University College, now the School of General Studies of the Australian National University. He retired in 1968.

Hope, Anthony (1863-1933), was an English novelist. His most famous novel is *The Prisoner of Zenda* (1894), a thrilling and romantic story set in an imaginary country, Ruritania. He wrote other novels, including a sequel, *Rupert of Hentzau* (1898), and *Sophy of Kravonia* (1906).

Anthony Hope was born in London and named Anthony Hope Hawkins. He was educated at Marlborough and Oxford. He was knighted in 1918.

Hope, Bob (1903-), is a popular American comedian and actor. He won fame for his fast-paced wisecracks in films, on radio and television, and on the stage.

Hope was born in London, England. His real name was Leslie Townes Hope. He moved to Cleveland, U.S.A., with his family at the age of 4. Hope became a vaudeville performer in the early 1920's and made his Broadway debut in 1927. He became a star in the musical comedy *Roberta* (1933). During the 1930's and 1940's, Hope starred in a popular radio show.

Hope has appeared in more than 50 films. His first feature film was *The Big Broadcast of 1938.* He received five special Academy Awards for his humanitarian activities and for his services to the film industry. He has also written several humorous books and an autobiography, *The Road to Hollywood* (1977).

Hope, John Adrian Louis (1860-1908), Earl of Hopetoun, was the first governor general of Australia. He was born at Hopetoun, Scotland, and educated at Eton. In 1889, he was appointed governor of Victoria, Australia. When the Australian states agreed on federation, he was appointed governor general. Failing health caused him to resign from his position and return to England.

Hopetoun House. See **Lothian Region.**

Hopkins, Sir Anthony (1937-), is a British actor. In 1992, he won the Academy Award for best actor in the film *The Silence of the Lambs* (1991). His other film credits include *84 Charing Cross Road* (1987) and *Howards End* (1992). He also works in theatre and television in the United Kingdom and the United States. In 1985, he won the Observer and Laurence Olivier awards for his performance in the play *Pravda.* He received Emmy awards in 1976 and 1981 for his television acting.

Sir Anthony Hopkins

Anthony Hopkins was born in Port Talbot, Wales. He attended the Welsh College of Music and Drama in Cardiff and the Royal Academy of Dramatic Art in London. He was knighted in 1993.

Hopkins, Sir Frederick G. (1861-1947), an English biochemist, discovered the existence of vitamins. He shared the 1929 Nobel Prize for physiology or medicine with the Dutch biologist Christiaan Eijkman.

Frederick Gowland Hopkins was born in Eastbourne, East Sussex. He studied at London University. In 1898, he established the department of biochemistry at Cambridge University. He was knighted in 1925.

Hopkins, Gerard Manley (1844-1889), ranks as a major poet of Victorian England, though his work remained almost unknown until 1918, when it was first published. Hopkins wrote most of his poetry in *sprung rhythm,* which emphasizes the natural rhythms and sounds of words. He filled his verse with alliteration and unusual word combinations. His poems, which are especially effective when read aloud, include the long and complex "The Wreck of the *Deutschland.*"

Hopkins was born in Essex. In 1863, he entered Oxford University. There, he experienced a spiritual crisis that led him to join the Roman Catholic Church in 1866. Hopkins entered the Jesuit order in 1868 (see **Jesuits**). He then stopped writing and burned the manuscripts of his poems. Hopkins returned to writing in 1875. He was ordained a priest in 1877.

See also **Poetry** (Sounds).

Hopkinson, John (1849-1898), a British electrical engineer, developed the theory and improved the construction of dynamos. He devised a method of distributing electricity using three wires to supply a double two-wire circuit. His method resulted in a considerable saving in wire. He also devised the *Hopkinson test,* a method of testing electric motors and generators by connecting two similar machines back-to-back so that one drives the other. Hopkinson was born in Manchester, England.

Hopman, Harry (1906-1985), was captain of the Australian Davis Cup tennis team in 1938 and 1939 and was nonplaying captain from 1950 to 1959. Under his leadership, Australia lost on only four occasions: 1938, 1954, 1958, and 1963. He was born in Sydney and named Henry Christian Hopman. He played in five Davis Cup competitions between 1928 and 1939. He also won the Australian squash rackets title three times.

Hopper, Edward (1882-1967), was an American painter. Hopper depicted ordinary scenes such as city streets and country roads, restaurants, shopfronts, and bedrooms. Through these everyday subjects, he expressed the feelings of loneliness and isolation that he recognized in American life. There are no people in many of his works. Even the paintings that show couples suggest melancholy and a lack of communication.

Hopper achieved a sense of loneliness and finality in his paintings through strong patterns of light and shade. The omission of distracting detail and the geometric arrangement of the compositions give Hopper's paintings an abstract power. An example is *Nighthawks,* which is reproduced in the **Painting** article.

Hopper was born in Nyack, New York, and lived in New York City. He worked as a commercial artist and illustrator for many years.

See also **Drawing** (picture: A charcoal drawing).

Horace (65-8 B.C.) was one of the greatest poets of ancient Rome. He is most famous for *Odes,* a collection of short, songlike poems. Some are personal poems about love, friendship, and natural beauty. Others express Horace's love for his country and his religion, using myths and tales of national heroes. See **Ode.**

Horace also wrote a more conversational kind of poetry called *satires* that make gentle fun of human weaknesses. The two books of *Satires* and a collection of ode-like poems called *Epodes* are Horace's earliest poetry. He later wrote verse letters to his friends about life and poetry. These letters make up the two collections called *Epistles.* See **Satire; Epistle.**

Horace was born in southern Italy. His full name in Latin, the language of ancient Rome, was Quintus Horatius Flaccus. His father, though a former slave, gave Horace an excellent education in Rome and Athens. Horace left his studies in Athens to join the army of Marcus Junius Brutus during Rome's civil war. After Brutus was defeated in 42 B.C., Horace returned to Rome. He became a civil servant and began to write poetry. Gaius Maecenas, a wealthy patron of the arts, made Horace his friend. Maecenas gave Horace an estate to support him so he was free to spend his time writing poetry.

See also **Latin literature** (The Augustan Age).

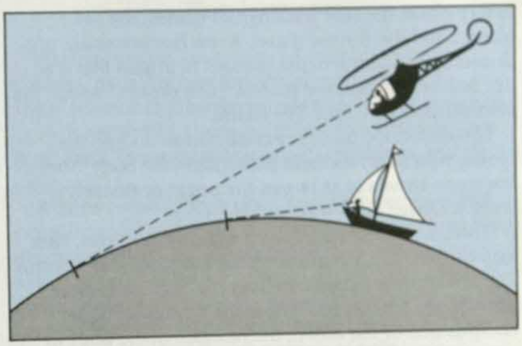
Horatius was a legendary Roman hero. Thomas Macaulay's *Lays of Ancient Rome* relates the story of Horatius' defence of the bridge over the Tiber River. When the last king of Rome was overthrown, he went to the Etruscans for help. The Etruscan army advanced to the bank of the Tiber River across from Rome. With two companions, Lartius and Herminius, Horatius held back the Etruscans while the Romans chopped down the bridge behind them. His friends ran back just in time, but Horatius remained alone until the bridge fell. Then, he jumped into the rushing Tiber and swam to safety. The people gave Horatius many gifts and erected a statue in his honour for his bravery in saving the city.

Hore-Belisha, Lord (1893-1957), Leslie Hore-Belisha, Baron Hore-Belisha of Devonport, became British secretary for war shortly before the outbreak of World War II (1939-1945). He was elected Liberal member of Parliament for Devonport, in Devon, in 1923. In 1934, he was appointed minister of transport. As transport minister, Hore-Belisha introduced pedestrian crossings and *Belisha beacons* (lighted beacons at pedestrian crossings). He also made driving tests compulsory. Hore-Belisha was born in London. He became a baron in 1954.

Horehound, also spelled *hoarhound,* is the name given to several plants in the mint family. The *common,* or *white, horehound* grows in the countryside and along the roads throughout Europe, North America, and northern Asia. The plant grows from 30 to 90 centimetres high. Many cottony white hairs cover it and give it a whitish appearance. The flowers are small and almost white. The leaves and stems have a pleasant odour and a bitter taste. Cough medicines and sweets are made from the leaves and stems. The *black,* or *fetid,* horehound, also used to make medicine, is a straggling, almost hairless plant with lilac flowers. It is found in Europe, central Asia, and North Africa.

Scientific classification. Horehound belongs to the mint family, Labiatae (Lamiaceae). White horehound is genus *Marrubium,* species *vulgare.* Black horehound is classified as *Ballota nigra.*

Horizon is the distant, curved line where the earth and sky seem to meet. Most people near the ground on land cannot see to the horizon because buildings, trees, or mountains block their view. But a person on board a ship can see all the way to the horizon on a clear day.



The distance to the horizon depends upon the position of the observer. The horizon the pilot sees is farther away than the horizon seen by the sailor, who is directly below the pilot.

The horizon seems nearer to a person standing at sea level than to a person in an aeroplane or on a mountain peak. This is because the person up high can see farther over the curvature of the earth than the person at sea level. The horizon is about 4 kilometres away to someone at sea level. But it is 113 kilometres from someone in an aeroplane or on a mountain 1 kilometre above sea level.

Astronomers and navigators have several technical meanings for horizon. The *visible* horizon is the imaginary line where the earth and sky seem to meet. The *astronomical,* or *sensible,* horizon refers to the imaginary line where the *celestial sphere* (curved dome of the sky) meets the imaginary level plane through a person's eye. Because the earth is curved, the visible horizon is slightly below the astronomical horizon. The angle between an observer and the two horizons is called the *dip.*

Hormone is any of a number of chemical substances produced within an animal or a plant. A hormone is produced in one part of an organism, but it causes an effect in a different part. Thus, hormones serve as a means of communication among various parts of an organism. They act as "chemical messengers" that help these parts function in a coordinated way.

The word *hormone* comes from a Greek word that means *to set in motion.* In human beings and other animals, hormones control such body activities as growth, development, and reproduction. In plants, hormones regulate many aspects of growth. If an organism fails to produce the proper kind or amount of hormones, serious disturbances—or even death—may result. For example, giants and dwarfs—among both animals and plants—can result from faulty hormone production.

In 1902, scientists found the first definite evidence of the existence of hormones. That year, British researchers discovered that a chemical substance controlled certain activities involved in digestion. Since then, scientists have identified more than 30 hormones produced by the human body. They also have developed ways of extracting hormones from living tissue and techniques for manufacturing them in the laboratory.

Human hormones

Most hormones in the human body are produced by organs called *endocrine,* or *ductless, glands.* The major endocrine glands include the two adrenal glands, the pituitary gland, the four parathyroid glands, the sex glands, and the thyroid gland. A few hormones are produced by endocrine tissue present in organs that are not primarily endocrine glands. Such organs include the stomach and pancreas. See **Gland.**

The endocrine glands secrete hormones into the blood, which carries them throughout the body. After a hormone arrives at its *target,* the organ or tissue it affects, it causes certain actions to occur.

Hormones regulate a variety of body functions. They may be grouped according to the functions they control. These functions include the way the body uses food; growth; sex and reproduction; the regulation of the composition of the blood; the reaction of the body to emergencies; and the control of hormones themselves.

Metabolic hormones regulate the various steps in *metabolism,* the process by which the body converts food into energy and living tissue. For example, the endocrine tissue of the stomach and small intestine secretes a number of *digestive hormones.* These hormones control the secretion of digestive juices, which break down food into simple substances.

After molecules of digested food enter the bloodstream, other hormones control their use by the cells of the body. For example, the hormones *insulin* and *glucagon,* both secreted by the pancreas, regulate the amount of sugar available to the cells. Insulin enables cells to use sugar from the blood. If the pancreas secretes too little insulin, a serious disease called diabetes mellitus results. Glucagon causes the liver to release additional sugar into the blood.

Two hormones produced by the thyroid gland—*thyroxine* and *triiodothyronine*—control the rate at which the cells use food to release energy. Overproduction of these hormones results in many physical and emotional disturbances, including excitability, muscular weakness, rapid pulse and respiration, and weight loss. Underproduction causes such symptoms as low body temperature, mental and physical sluggishness, and weight gain. By controlling the production of energy, these hormones regulate the way in which the body uses food in building new tissue. Thus, they play a major role in the creation of new proteins by the body cells.

Other hormones also control the way cells use food to build new tissue. The *glucocorticoids* are a group of hormones that function primarily in regulating the metabolism of *carbohydrates* (sugars and starches), fats, and proteins. They control the processes by which the body converts digested proteins into carbohydrates and fats. These hormones include *corticosterone, cortisol,* and *cortisone.* The glucocorticoids are secreted by the *cortex* (outer part) of each adrenal gland. Insulin and *growth hormone* (GH), a hormone secreted by the *anterior lobe* (front part) of the pituitary gland, also regulate the creation of new tissue.

GH also controls the use of food in other ways. For example, it stimulates cells to use fat, rather than sugar, as an energy source, and so helps maintain a fairly high level of sugar in the blood. Such a level is necessary for the brain to function properly.

Growth and sex hormones. The body's development from infancy to adulthood involves a complex process of physical changes. Hormones play a key role in regulating these changes.

GH controls overall growth during childhood. Faulty production of this hormone during childhood can cause a person to become a dwarf or a giant. In adults, GH enables certain tissues to maintain their proper size and structure. Insulin, glucocorticoids, and thyroxine also play major roles in tissue growth and maintenance.

Beginning at the age of about 11 to 15, young people go through a period of rapid growth and physical change. Hormones control the development that occurs during this period, called *puberty.*

At the start of puberty, the *hypothalamus,* the portion of the brain nearest the pituitary gland, greatly increases its secretion of *gonadotropin-releasing hormone.* This hormone acts on the anterior lobe of the pituitary. It stimulates the gland to secrete the *gonadotropic hormones—follicle-stimulating hormone* (FSH) and *luteinizing hormone* (LH). These hormones, in turn, act on the *gonads* (sex glands)—the testicles in males and the ovaries in females.

Under the influence of FSH and LH, the gonads grow and begin to secrete large amounts of *sex hormones.* The male sex hormones, including *testosterone* and *androsterone,* are called *androgens.* The female sex hormones include *progesterone* and the *oestrogens.* The most important oestrogens are *oestradiol, oestriol,* and *oestrone.* The cortex of adrenal glands in men and women also secretes some sex hormones, especially androgens.

The sex hormones regulate the remarkable changes that occur during puberty. They help trigger a person's rapid growth in height and weight and, at the end of puberty, they stop this growth. Androgens cause the male sex organs to mature, and they stimulate male sexual behaviour. Androgens also stimulate the development of such secondary male characteristics as a deep voice and a beard. Oestrogens cause the female sex organs to develop fully, and they establish female sexual behaviour. They also stimulate the development of secondary female characteristics, such as full breasts and wide hips. In a woman's body, FSH, LH, oestrogens, and progesterone work together to control the menstrual cycle (see **Menstruation**). Progesterone also regulates processes necessary for pregnancy.

Blood composition hormones. Healthy blood contains fairly exact levels of several chemical substances. If the level of these chemicals becomes too high or too low, the body can be harmed.

A number of hormones work together to ensure that the composition of the blood remains within normal ranges. *Parathormone,* secreted by the parathyroid glands, and *calcitonin,* from the thyroid, both regulate the level of calcium in the blood. Parathormone also controls the amount of phosphate in the blood. The *mineralocorticoids,* a group of hormones secreted by the adrenal cortex, control the balance between salts and water in the blood. *Aldosterone* is the most important mineralocorticoid. *Vasopressin,* also called *antidiuretic hormone,* regulates the water level of the blood. It is produced by the hypothalamus, but it is stored in and released by the *posterior lobe* (rear part) of the pituitary.

Stress hormones are secreted in anger, fright, or injury. The *medulla* (inner portion) of the adrenal glands secretes *adrenaline* and *noradrenaline.* These substances, particularly adrenaline, prepare the body for stress. For example, adrenaline increases the pulse and speeds the conversion of food to energy in the muscles. The glucocorticoids also help the body adjust to stress.

Endocrine control hormones affect the production of other hormones. They include FSH and LH, the anterior pituitary hormones that regulate the secretions of the gonads. The anterior pituitary also secretes *thyroid-stimulating hormone* (TSH) and *adrenocorticotropic hormone* (ACTH). TSH stimulates the thyroid to secrete thyroxine. ACTH stimulates the adrenal cortex, causing increased secretions of glucocorticoids, mineralocorticoids, and adrenal sex hormones.

The anterior pituitary itself is regulated by hormones released by the hypothalamus. These substances are called *releasing hormones.* The gonadotropin-releasing hormone triggers the secretion of FSH and LH. Other releasing hormones stimulate the pituitary's production of ACTH, GH, and TSH. *Prolactin,* another hormone of the anterior pituitary, is also controlled by a hypothalamic hormone. One of the effects of prolactin is the stimulation of milk production in nursing mothers.

The hypothalamus, which forms part of the brain, consists of nerve tissue. Thus, the releasing hormones link the body's nervous and endocrine systems into one coordinated control unit. The sense organs gather information on changes in the environment, which they relay to the brain through the nervous system. If these changes call for a hormonal response, the hypothalamus triggers the appropriate pituitary secretions.

Other hormones in human beings include *oxytocin* and *relaxin,* both of which affect the process of birth. Oxytocin, like vasopressin, is produced by the hypothalamus and is stored in and secreted by the posterior pituitary. The ovaries produce relaxin. Relaxin widens the birth canal, the passageway through which a baby leaves its mother's body. Oxytocin causes the muscles of the uterus to contract during labour. Oxytocin also stimulates the release of milk from the mother's breasts when the infant nurses.

Melanocyte-stimulating hormone (MSH) is a hormone secreted by the anterior lobe of the pituitary. Among certain amphibians, fish, and reptiles, MSH regulates the amount of *pigment* (colouring matter) in the skin. The function of this hormone in the human body is not yet understood.

Hormones of other animals

Other vertebrates, especially other mammals, have most of the same hormones people have. These chemicals are nearly identical in structure and effect to human hormones. Thus, scientists can learn about human hormones by studying those of other vertebrates. Doctors use hormones secreted by these animals to treat patients whose body does not produce sufficient amounts of certain hormones. For example, millions of people with diabetes use insulin obtained from cattle, pigs, and sheep.

Invertebrates also have hormones, some of which play an important role in growth and development. For example, hormones control the series of changes through which such insects as bees and butterflies pass while growing. Scientists do not know so much about invertebrate hormones as they do about those of vertebrates.

Plant hormones

Plant hormones are produced mainly in actively growing parts, such as the tips of roots and stems. These hormones influence growth and are often called *growth regulators.* There are three main types of plant hormones. These are: (1) *auxins,* (2) *cytokinins,* and (3) *gibberellins.*

Auxins cause various effects on different parts of a plant. In stems and roots, auxins regulate the *elongation* (lengthening) of cells. By stimulating cell elongation, auxins affect the manner in which stems bend towards light and away from gravity. Auxins also control the process by which roots bend toward gravity, but they do so by preventing the elongation of cells.

In many plants, auxins secreted by the bud at the tip of a stem prevent lower buds on the stem from growing. Thus, they slow the growth of side branches. Such branches could use up energy a plant needs to grow tall and sturdy. Auxins also stimulate the growth of fruit and prevent fruit and leaves from falling off a plant.

Cytokinins control cell division in plants. They apparently work together with other growth regulators, especially auxins. Cytokinins play an important role in determining which cells of a young plant will become root cells, which cells will become leaf cells, and so on.

Gibberellins stimulate many plants to grow larger. When used in experiments, they have made the stems of dwarf plants lengthen rapidly. Gibberellins also help regulate blossoming in certain plants. They cause the seeds and buds of many species to begin growing after *dormancy* (long periods of inactivity).

Other growth regulators include *abscisic acid* and *ethylene.* Abscisic acid blocks plant growth, thus stimulating dormancy. Ethylene regulates, among other things, the ripening of fruit.

How hormones work

Most human hormones can be divided into two groups according to their chemical structure. One group, called *steroids,* consists of the sex hormones and the hormones of the adrenal cortex. Most other human hormones contain some form of *amino acids,* the building blocks of proteins.

Scientists believe the chemical structure of a hormone enables it to combine with a *receptor* in the cells of its target. The union of the hormone with the receptor triggers a change in the chemical processes of the cell. This change, in turn, probably modifies many, if not all, of the hundreds of chemical activities of the cell. These changes in cell activity cause the target to behave in a certain way.

Many *endocrinologists* (doctors who treat hormonal disorders) think steroid hormones become attached to receptors and then enter the nucleus of the target cell. In the nucleus, the hormone affects the activity of the *genes,* the tiny units that contain hereditary information. The endocrinologists believe amino acid-based hormones probably unite with receptors on the outer membrane of the target cell. This union may change the structure of the cell membrane, allowing certain substances to enter or leave the cell. These substances alter the chemical activities of the cell. In other cases, the union seems to influence the activity of enzymes located on the membrane. The enzymes react by causing the formation of a substance called *cyclic AMP.* This substance, in turn, alters the cell's chemical activities.

Synthetic hormones

Since the 1940's, biochemists have learned to *synthesize* (create artificially) many hormones in the laboratory. Until that time, almost all hormones had to be extracted from animals or plants. Only tiny quantities of hormones occur in living tissue. Synthesis has greatly increased the availability of hormones for human use.

Some synthetic hormones, including synthetic human hormones, are exact duplicates of the natural secretions. But scientists have altered the chemical structure of many synthetic hormones to provide more powerful action. The most common synthetic hormones include auxins; glucocorticoids, particularly cortisone; sex hormones; growth hormone; and insulin.

Not all hormones can be synthesized. Scientists do not know the exact chemical structure of some. The structure of other hormones is too complex for practical large-scale synthesis.

Uses of hormones

Medical uses. Doctors use hormones to treat people with *hormone deficiencies.* The body of a patient with such a condition cannot produce an adequate supply of one or more hormones. Hormone therapy enables a person to overcome many of the symptoms of various diseases. Such therapy cannot cure these diseases. It merely controls them.

Hormone deficiency diseases include Addison's disease, diabetes mellitus, diabetes insipidus, and myxoedema. See **Addison's disease; Diabetes; Thyroid gland** (Underactive thyroid).

Certain other conditions, which are not directly related to hormone deficiencies, may also be treated with hormones. These conditions include arthritis and asthma, for which many doctors prescribe the hormone cortisone.

In addition, hormones may be given to alter a function of the body in some way. Birth control pills, for example, contain synthetic female sex hormones. By taking these hormones, a woman alters the endocrine balance that controls the menstrual cycle. This alteration blocks *ovulation* (the release of eggs), thus making it almost impossible for pregnancy to occur.

Agricultural uses. Farmers use synthetic plant hormones, especially auxins, to achieve a variety of results in crop production. When treated with auxins, certain plants—including cucumbers and tomatoes—produce seedless fruit. Farmers also use auxin sprays on apples to prevent the fruit from falling off the tree before harvest. In addition, auxins serve as weedkillers. When sprayed in large concentrations, auxins cause broadleaf weeds to grow in an uncontrolled manner so that they soon die.

Much research has been done on the use of hormones in livestock production. In some countries, certain synthetic oestrogens are used to stimulate the fattening of cattle. The use of one such growth stimulant, known as *diethylstilbestrol* or *DES,* was discontinued when it was found to be linked to the development of cancer in human beings.

Related articles in *World Book* include:

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Goitre
Growth
Hypothalamus
Insulin
Oestrogen
Ovary
Pancreas
Parathyroid gland
Pituitary gland
Progesterone
Prostaglandin
Steroid
Testicle
Testosterone
Thyroid gland

Hormuz, Strait of. See **Persian Gulf.**

Horn is the general name for instruments of the brass family. The most popular include the bugle, cornet, flügelhorn, French horn, trombone, trumpet, and tuba. The term *horn* often refers only to the French horn.

Most horns are made of brass, though a few are made of plastic or silver. Horns consist largely of tubing in many shapes and lengths. The differences in tubing produce a great variety of tone colours, ranging from the brilliant sound of the trumpet to the warm, mellow sound of the French horn. The pitches of all horns are determined by the tension of the player's lips in the instrument's mouthpiece. Horns also have valves or slides that permit additional changes in pitch.

The earliest horns were made from natural materials, such as animal horns, tusks, shells, or hollow lengths of wood. People used horns to send signals over distances too great to be covered by the human voice. As sophisticated instruments developed, various types of horns became popular in military bands and orchestras.

However, in many parts of the world, horns made of natural materials are used today for signalling or to accompany dances or ceremonies. The oldest known horn is the ancient Hebrew *shofar,* made from a curved ram's horn. This instrument dates back about 6,000 years and is still used in Jewish religious services.

Related articles in *World Book* include:

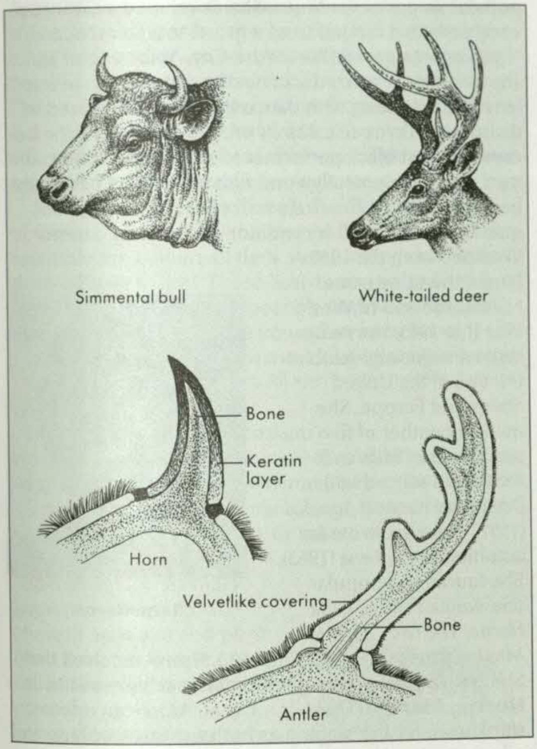
Alpenhorn
Bugle
Cornet
Flügelhorn
French horn
Mellophone
Music (Wind instruments)
Trombone
Trumpet
Tuba

Horn is a pointed, bony structure on the heads of many mammals. Most horned animals have a pair of horns. Such animals as cattle, sheep, goats, and antelope have true horns. Deer have hornlike growths that are not true horns. These growths are called *antlers.*

Horns have a bony core. The core is an extension of one of the skull bones. A layer of skin covers the core. This skin contains a large amount of a protein called *keratin.* Keratin makes the horn extremely tough and durable. See **Keratin.**

Among many horned animals, both the male and the female grow horns. The horns may be elaborately curved, but—except in the pronghorn antelope—they do not form branches as do antlers. Horned animals keep their horns for life. The pronghorn sheds the coverings of its horns and grows new coverings each year.

Among most antlered animals, only the male grows antlers. The animal sheds its antlers every year. Like horns, antlers grow out of bones in the skull. At first, antlers have a velvetlike covering of skin over the bone. But instead of becoming hard, this covering dies and is



Horns and antlers differ in structure. Horns are permanently covered by hard, keratin-rich skin. Antlers have a velvetlike covering that the animal eventually rubs off. Cross sections of a bull's horn and a deer's antler are shown above.

rubbed off by the animal. See **Deer** (Antlers; picture: How a deer's antlers grow); **Moose** (picture).

Horns and antlers have a number of functions. They serve as weapons to protect the animals from attack. Male animals sometimes use their horns or antlers to fight other males in the group. Such fighting establishes which male is the most important. More often, a male avoids a fight and establishes his superiority through gestures that may include displaying and threatening to use his horns or antlers.

Horn of plenty. See **Cornucopia.**

Hornbeam is a broadleaf tree closely related to the birch. There are about 20 species of hornbeam, which grow in the temperate zones of the Northern Hemisphere.

Hornbeams are similar in appearance to beeches, but smaller. The leaves of the hornbeam have sharp points and serrated edges. The catkins, which are enclosed in buds in winter, appear with the new leaves. The fruit is a cluster of winged seeds.

The common hornbeam, native to Europe and Asia Minor, grows to a height of about 25 metres. The white timber is very hard and durable. It was once used to make tool handles and ox-yokes. Today hornbeam is used for billiard cues, drumsticks, and some inner parts of pianos.

Scientific classification. Hornbeams are in the Corylaceae family. The common hornbeam is *Carpinus betulus.*

The red billed hornbill lives in Africa.

Hornbill is the name of 45 species of medium-sized to large birds with huge, often colourful, bills. Hornbills are found in tropical Africa and Asia. They eat fruit, insects, reptiles, and small mammals. Hornbills use their clumsy-looking bills with great skill. For example, the bird holds poisonous snakes at the tip of the bill and rolls the snake back and forth until it is crushed.

Hornbills have unusual nesting habits. In all but two species, the female lays one to five eggs within a cavity in a hollow tree. The female then imprisons herself and her eggs inside the nest chamber by blocking the entrance hole with a cement like wall built from her droppings. The male passes food to the female through a narrow slit in the wall. In some species, the female remains walled in the nest for over 100 days until she and her grown young burst free.

Scientific classification. Hornbills make up the hornbill family, Bucerotidae.

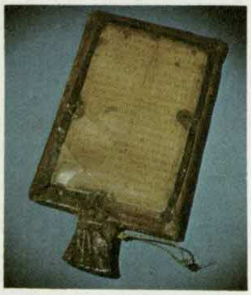
Hornblende is any of a group of fairly hard rock-forming minerals. It is the most common type of *amphibole.* An amphibole is a *silicate,* a mineral composed chiefly of silicon and oxygen that is found throughout the earth's crust. Hornblendes occur in many *igneous* and *metamorphic* rocks (see **Rock**).

Hornbeams grow well in a rich loam or clay soil.

Hornblendes range in colour from dark green to dark brown or black. Most hornblendes occur as shiny crystals that are shaped like a prism. But some are small, irregularly shaped grains. All hornblendes contain aluminium, calcium, iron, and magnesium in addition to silicon and oxygen. Many also have potassium, sodium, and titanium. Hornblendes vary widely in chemical composition. For example, one variety called *hastingsite* is rich in sodium and iron. Another known as *tschermakite* has much aluminium.

Hornbook. Paper was scarce and expensive during the Middle Ages and until the early 1800's. It had to be used sparingly. The hornbook was invented to protect the paper on which the first lessons of young children were printed. It was used as early as 1442. By the end of the 1500's, the hornbook was standard equipment in English schools. Its use continued in England and America until about 1800, when books became cheaper. Today, hornbooks are very valuable and have become rare collector's items.

The hornbook was a flat board with a handle. On the board was pasted a sheet of paper with the simple lesson of the beginning student. On the paper were usually the alphabet, the Benediction, the Lord's Prayer, and the Roman numerals. The alphabet often was given, with the vowels heading the list, followed by combinations of vowels and consonants, such as *ab, eb, ib, ob,* and *ub.* The whole board was covered with a thin, flat piece of clear horn, through which a person could read the paper. The flattened horn was made transparent by boiling and scraping.


Hornbook

The handles of many hornbooks had holes so that the hornbooks could be worn around the neck or fastened to a belt. In some wealthy English families the children were given extremely ornate hornbooks. The backs of the boards were of leather ornamented with pictures or designs inlaid with silver or gold filigree. American settlers had simpler hornbooks.

In the 1700's, gingerbread "hornbooks" were often made. Children were allowed to eat a letter of the alphabet that they had learned. Hornbooks were used only in England and America.

Horne, Donald (1921-), an Australian author, wrote *The Lucky Country* (1964). It was an evaluation of Australian society in the 1960's that questioned many traditional attitudes. He later wrote several other works, including *The Education of Young Donald* (1967) and *Confessions of a New Boy* (1985). Horne was born in Sydney and was educated at Sydney University and Canberra University College. He was editor of *The Bulletin* in 1961 and 1962 and from 1967 to 1972. From 1973 to 1986, he worked at the University of New South Wales, where he was made a professor with a personal chair. He became chairman of the Australia Council in 1985.

Horne, Lena (1917-), is an American singer and actress. She became famous for her beauty and as a popular singer of the blues. She developed a distinctive vocal style that ranged from a growl to a soft croon.

Horne was born in New York City. At the age of 16, she became a chorus dancer at the Cotton Club in Harlem. She then sang with dance bands and appeared in the musical revue *Blackbirds of 1939.* In 1942, Horne became the first black performer to sign a long-term contract with a major Hollywood film studio. She had made her film debut in *The Duke Is Tops* (1938), but did not gain attention until her rendition of the song "Stormy Weather" from the 1943 film of the same name.

Lena Horne

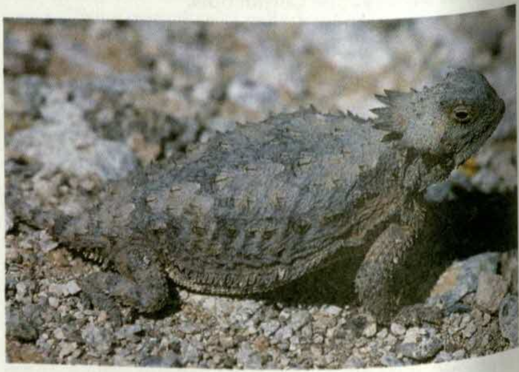
After the end of World War II in 1945, Horne became a major nightclub attraction in the United States and Europe. She made a number of film musicals in the 1940's and 1950's and starred in the Broadway musical *Jamaica* (1957). She also wrote an autobiography, *Lena* (1963). She toured in a popular one-woman show, *Lena Horne: The Lady and Her Music,* in the early 1980 's. In 1983, Horne received the Spingarn Medal in recognition of her achievements.

Horne, Marilyn (1934-), is an American opera star known for her singing as both a mezzo-soprano and a soprano. Her broad vocal range, which includes both soprano and contralto notes, has allowed her to sing an unusual variety of roles. Horne has also won fame for the rich quality of her lower voice.

Horne became famous for her performances in operas composed in the Italian *bel canto* style, which emphasizes beautiful tones and technical skill. She has sung roles in bel canto operas written by such composers as Vincenzo Bellini, Gaetano Donizetti, and Gioacchino Rossini.

Horne was born in Bradford, Pennsylvania. She made her operatic debut in 1954 with the Los Angeles Guild Opera in *The Bartered Bride.* Horne first sang with the Metropolitan Opera in 1970 in *Norma.*

Horned lizard is the name of 14 species of North American lizards. They are often called *horned toads* or


A horned lizard has sharp spines on its head and its back. It feeds on ants and other insects.

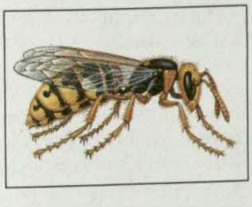
horny toads because their body has a flattened, toadlike shape. Horned lizards grow to 6.5 to 16.5 centimetres long. Their bodies are covered with sharp spines. Large hornlike spines project from the back of their heads. Their spiny armour protects them from attacking animals. When attacked, horned lizards sometimes squirt little streams of blood from their eyes. This ability may help them ward off such enemies as coyotes.

Horned lizards live in deserts and other dry regions of Canada, Mexico, and the United States. Their colours resemble the colours of their surroundings and make them difficult to find. These lizards move slowly and feed chiefly on insects, especially ants. Most species lay eggs. In a few species, the young are born living.

Scientific classification. Horned lizards belong to the New World lizard family, Iguanidae. All species are members of the genus *Phrynosoma.*

See also **Lizard** (Defences).

Hornet is the name of any one of several large social wasps. It was originally the name given to the European hornet, but now refers to many large wasps. Hornets nest in trees or in the eaves or rafters of houses.



A hornet

Hornets were the first papermakers. They make large paper nests from chewed up wood and plant fibre. A mated female called the *queen* starts to make the nest in the spring. She constructs several hexagonal cells, lays a few eggs, and feeds the larvae. All the young of this first brood are females. They become *workers* who help the queen enlarge the nest, gather food, and rear additional broods. Hornets use their nest for only one season. In the autumn, new queens and males are born. After mating, the queens leave the nest to hibernate in a protected location. The workers and males die after the first frosts.

Hornets construct large paper nests from chewed-up wood and plant fibre. They frequently build their nests in trees.

Hornets are nervous insects that will readily sting if disturbed. Stinging injects a *venom* (poison) that causes a painful swelling that may last for some time. Nevertheless, hornets are helpful insects. Workers capture flies, caterpillars, and other pests for the queen's young.

Scientific classification. Hornets are members of the family Vespidae. The European hornet is *Vespa crabro.*

See also **Wasp; Insect** (picture: Order Hymenoptera).

Horney, Karen (1885-1952), was a German-born psychoanalyst. She became known chiefly for challenging the Austrian doctor Sigmund Freud over the stress he put on biology in explaining human psychology. Horney believed that people often behave as they do for social reasons, not biological ones.

Horney particularly criticized Freud's views on the psychology of women. Freud said that all women feel inferior to men by instinct. Horney agreed that many women do feel that way—but not because of instinct. She argued that it is society that teaches women to feel inferior.

Horney was born Karen Danielsen in Hamburg. She married Oscar Horney, a Berlin lawyer, in 1909. She gained a medical degree from the University of Berlin in 1913. In 1932, Horney moved to the United States. She helped form the American Institute for Psychoanalysis in 1941 and served as its dean until her death. Her major works include *The Neurotic Personality of Our Time* (1937), *Self-Analysis* (1942), and *Our Inner Conflicts* (1945).

Horniman, Annie (1860-1937), a wealthy theatrical producer and patron, helped to promote the modern theatre in Britain and in Ireland. In 1904, Horniman bought an old theatre in Abbey Street, Dublin, and lent it rent-free to the Irish National Theatre Society. The society formed the Abbey Theatre (see **Abbey Theatre**).

In 1908, Horniman rebuilt and reopened the Gaiety Theatre, Manchester, as the first modern repertory theatre in Britain. Between 1908 and 1921, she staged over 300 plays, including many modern ones. Annie Elizabeth Fredericka Horniman was born in London into a famous family of tea planters. For five years she was secretary to the Irish poet W. B. Yeats.

Hornung, E. W. (1866-1921), an English novelist, was the author of the *Raffles* stories. He wrote 28 books, specializing in exciting tales. He made his name in 1899 with *The Amateur Cracksman,* the story of Raffles, a gentlemanly burglar. He followed this book with *Raffles* (1901), *A Thief in the Night* (1905), and *Mr. Justice Raffles* (1909). Among his other books were *The Unbidden Guest* (1894) and *The Crime Doctor* (1914). Hornung was born in Middlesbrough, Cleveland, and was educated at Uppingham School.

Hornwort is the name of a group of small, nonflowering plants related to mosses and liverworts. There are over 300 species of hornworts. They are found throughout the world, but are especially common in tropical regions and in areas with warm, moist climates. Hornworts grow mainly on bare, damp soil that is shaded. They are often found along roadsides or near the edges of streams or lakes.

A hornwort reproduces in a cycle called *alternation of generations* (see **Alternation of generations**). It has two distinct forms during its life cycle, the *gametophyte* and the *sporophyte.* The gametophyte is made up of a simple plant body called the *thallus.* The thallus looks like a mound of ruffled, dark-green leaflets. It grows along the ground and is usually 1 to 2 centimetres across. The thallus is anchored to the soil by rootlike structures called *rhizoids.* The sporophyte is long and slender. It may be from 0.5 to 12 centimetres high. The sporophyte grows upward from the thallus and resembles horns, giving the plant its name.

Hornwort sporophytes

Scientific classification. Hornworts make up the class Anthocerotopsida in the division Bryophyta. Altogether there are six genera.

Horoscope is a chart that supposedly reveals a person's character or future. The chart shows the position of the earth, planets, and stars at a certain time, such as the time of a person's birth. *Astrologers* (people who tell fortunes by studying the stars) believe that the position of these bodies influences a person's life. An astrologer *casts* (draws) a person's horoscope and explains its supposed meaning.

Most scientists would say that there is no scientific basis for a belief in horoscopes. Yet, many people believe in horoscopes and base important decisions on advice they receive from astrologers. Others find it amusing just to read general advice published in newspaper "horoscope" columns.

Parts of a horoscope. A horoscope has three main parts that represent three supposed influences on a person's life. The three parts are: (1) the zodiac, (2) the houses, and (3) the planets.

The zodiac is a band of stars that appears to encircle the earth (see **Zodiac**). The zodiac consists of 12 divisions called *signs.* Astrologers believe that a person comes under the special influence of a particular sign, depending on the date of the person's birth. For example, a person born from July 23 to August 23 has Leo as a zodiac sign and is often called "a Leo." Each zodiac sign has certain characteristics. For example, a Leo supposedly displays cheerfulness and pride. A person born between January 20 and February 18 would according to the zodiac sign be "an Aquarian", and therefore supposedly outgoing and independent.

The houses represent imaginary divisions of the surface of the earth. Astrologers believe there are 12 houses, which are represented by 12 divisions of a person's horoscope. Each house supposedly influences a certain part of a person's life. The first house, for example, is associated with an individual's appearance and personality. Other houses affect a person's career, health, marriage, or some other interest.

The planets, according to astrologers, include the moon and sun as well as Jupiter, Mars, Mercury, Neptune, Pluto, Saturn, Uranus, and Venus. The planets supposedly have an important influence on the houses and signs. A particular planet *rules* (most influences) each sign. This planet has certain characteristics that affect the sign it rules. For example, Mercury, which is associated with talkativeness and wittiness, rules Gemini. Therefore, people born under the sign of Gemini are supposedly talkative and witty.

Astrologers also believe that the planets influence the activities or interests associated with individual houses. For example, if Venus (associated with beauty) were located in the first house (associated with appearance), an astrologer would conclude that the person had an attractive physical appearance. The various planets in a person's chart lie at particular angles to one another. These angles, called *aspects,* also have meaning. Astrologers believe that certain angles represent signs of good fortune. Other angles supposedly reveal approaching evil.

Explaining a horoscope. A horoscope enables an astrologer to develop several kinds of character readings. Some horoscopes, for example, give only a general idea of an individual's character or future. Most of the horoscopes published in newspapers are of this type. They make predictions based only on the characteristics of the zodiac signs. Such a horoscope might tell people born under the sign of Taurus simply that they face an important test in their career.

Astrologers may also cast a complete horoscope and study the complicated relationships formed by the houses, planets, and zodiac signs. For example, suppose that Saturn was located in the first house in the horoscope and in the sign of Virgo. An astrologer would probably conclude that the person was extremely neat both in manner of dress and habits. The astrologer would reach this conclusion because Saturn, a disciplined planet, is in the house of physical appearance and personality, under the sign of Virgo, which is associated with tidiness.

See also **Astrology; House** (in astrology); and the articles on signs of the zodiac, such as **Aries.**

Horowitz, Vladimir (1904-1989), a Russian-born pianist, was one of the world's greatest musicians. He won fame for his magnificent technique, which combined outstanding power and attention to detail. His performances featured the works of composers of the 1800's and 1900's.

Horowitz was born in Kiev, Russia, and received his early training there. In 1925, he began to play in leading European cities with the most famous conductors. Horowitz first performed in the United States in 1928. He settled in the United States in 1940 and became a U.S. citizen in 1944.

Horowitz did not perform from 1953 to 1965. Beginning in 1965, he gave a number of recitals, which were highly praised by critics.

Horrocks, Sir Brian (1895-1985), a British soldier and military writer, served in World Wars I and II. Horrocks was born at Ranniket, in India, and educated at Uppingham School. He fought in France and Belgium during World War I and took part in the campaign against the Bolshevik regime in Russia in 1919. He fought in North Africa in World War II. In 1944, he took part in the Allied invasion of northern France. Horrocks commanded the British occupation forces in Germany in 1948. He was Gentleman Usher of the Black Rod in the House of Lords from 1949 to 1963. As a military historian and writer, he edited a series of books on famous regiments, and wrote *A Full Life* (1960).

The beauty of horses contributes to their great popularity. The powerful bodies and flowing manes and tails of the Arab horses shown above give the animals a noble appearance.

Horse

Horse has been one of the most useful animals for thousands of years. Horses once provided the fastest and surest way to travel on land. Hunters on horseback chased animals and killed them for food or for sport. Asian hordes conquered Europe and medieval knights charged into battle on sturdy war horses. European settlers used horses when they colonized Africa, America, and the Indian subcontinent.

The horse is not as important as a means of transportation as it once was. In most countries, the *iron horse* (train) and *horseless carriage* (car) have replaced the horse almost entirely. But people still use horses for recreation, sport, and work. Large crowds thrill to the excitement of horse races. Horses perform in circuses, carnivals, gymkhanas, parades, rodeos, and horse shows. They help ranchers to round up great herds of cattle, and they may be used to pull ploughs and do other farm work.

The horse is well-suited for working and running. For example, its wide nostrils help it breathe easily. Horses have a good sense of smell, sharp ears, and keen eyes. They have strong teeth, but they eat only grain and plants, never meat. Long, muscular legs give horses the strength to pull heavy loads or to run at fast speeds. Horses also use their legs as their chief weapons. The kick of a horse can seriously injure a human being or an animal. A bite from a horse can tear flesh from bone.

Horses are eager to please their owners. Most horses have good memories and can easily be trained to obey commands. A horse may learn to come when its owner whistles. A circus horse takes "bows" when its trainer touches its front legs with a whip. Horses can learn to respond to even the slightest signals.

People who watch an expert rider on a well-trained horse often cannot see the signs the rider uses. For example, the horse moves forward when the rider's legs are pressed lightly against the horse's side. It turns at a touch of the reins against its neck. The quick obedience of the horse has helped make it one of our most valuable animals.

People have improved the natural qualities of the horse by breeding various kinds of horses. Horsebreeders can breed a fast horse with a strong horse to produce an animal that has both speed and power.

Kinds of horses

After the last Ice Age (10,000 years ago), three distinctive types of horses emerged. They were the ancestors of all our modern horses. In Asia there was the *steppe horse,* which is now extinct in the wild but survives in a number of zoos. It is also called *Przewalski's horse,* after the Russian colonel who discovered a wild herd in Mongolia in 1881. The *plateau horse* or *tarpan* lived in huge areas of eastern Europe and the Ukrainian steppes. It was hunted almost to extinction, but a small herd survives at Popielno in Poland. These animals are probably replicas, produced by careful cross-breeding over many years. The third species was the *forest* or *diluvial horse.* It was a massive, slow-moving beast, living in the wet pasturelands of northern Europe. It is now certainly extinct.

Experts believe that Przewalski's horse and the tarpan are the direct ancestors of today's *light horses* (animals that have Arab and thoroughbred blood). Today's heavy *draught horses* (pulling horses) are descendants of the forest horse.

There are now more than 150 breeds and types of horses and ponies. The breeds vary greatly in size, strength, speed, and other characteristics. The smallest breed is the Falabella, which grows only 75 centimetres high. Falabellas were originally bred in Argentina and are kept as pets. The largest breed of horse is the shire, which was originally developed in England. Shires may measure more than 170 centimetres high. They may weigh more than 910 kilograms.

Shires and other large breeds, such as the Belgian, Clydesdale, and Percheron, are the strongest horses. They can pull loads that weigh up to one metric ton. The two fastest breeds are the quarter horse and the thoroughbred, which are often bred and trained for racing. The quarter horse can run nearly half a kilometre in about 20 seconds. But the thoroughbred can run longer distances faster. It can cover about 1.5 kilometres in about $1\frac{1}{2}$ minutes.

Horse terms

Bronco, or **Bronc** in the United States, is an untamed horse.
Colt, technically, is a male horse less than 4 years old. However, the word *colt* is often used for any young horse.
Crossbred means bred from a sire of one breed and a dam of another.
Dam is the mother of a foal.
Filly is a female horse less than 4 years old.
Foal is either a newborn male or a newborn female horse.
Frog is the elastic, horny, middle part of the sole of a horse's foot.
Gait is any forward movement of the horse, such as walking or galloping.
Gelding is a male horse that cannot be used for breeding because it has had its reproductive organs removed.
Grade is a horse or pony of mixed breed.
Hand is a unit used to measure the height of a horse, from the ground to the highest point of the withers. A hand equals 4 inches (10.16 centimetres).
Mare is a female horse more than 4 years old.
Mustang is the wild horse of the Western plains of North America, descended from Spanish horses.
Pony is any small horse, but the word *pony* usually refers to a horse less than 145 centimetres tall when full-grown.
Purebred means bred from horses that are of the same breed.
Sire is the father of a foal.
Stallion is a male horse that can be used for breeding.
Yearling is a horse that is more than 1 and less than 2 years old. A race horse is considered a yearling from the first January 1 after its birth until the following January 1.
Withers is the ridge between a horse's shoulder bones.

Some types and breeds of horses

Type or breed	Place of origin	Weight in kg	Height in hands*
Saddle horses			
American saddle horse	United States	410 to 540	14.3 to 16.1
American quarter horse	United States	410 to 540	14.2 to 15.3
Appaloosa	United States	430 to 530	14.2 to 15.2
Arab	Arabia	390 to 450	14.2 to 15.3
Morgan	United States	360 to 500	14.2 to 15.2
Palomino	United States	410 to 590	14.1 to 16
Tennessee walking horse	United States	410 to 540	15 to 16
Thoroughbred	England	450 to 590	15 to 17
Light harness or roadster horses			
Hackney	England	410 to 540	14.3 to 16.2
Standardbred	United States	360 to 540	15 to 16
Draught horses			
Belgian	Belgium	770 to 1,000	16 to 19
Clydesdale	Scotland	680 to 910	16 to 17.1
Percheron	France	730 to 950	15 to 17
Shire	England	820 to 1,040	16 to 17
Suffolk	England	680 to 860	15.2 to 16.2
Heavy harness or coach horses			
Cleveland bay	England	570 to 700	15.3 to 16.3
French coach	France	500 to 640	15.1 to 16.3
German coach	Germany	540 to 680	15.2 to 16.3
Ponies			
Hackney pony	England	270 to 390	12 to 14.2
Pony of the Americas	United States	230 to 410	11.2 to 13.2
Bhutia	India	400 to 410	13 to 13.1
Shetland pony	Shetland Islands	140 to 230	9 to 11.2
Spiti	India	270 to 275	12 to 12.2

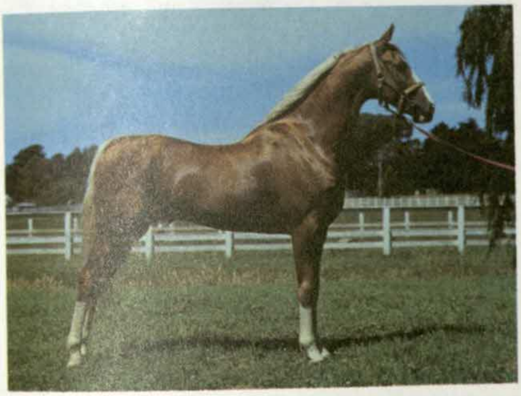
*One hand equals 4 inches (10.16 centimetres)

The various breeds of horses are commonly divided into three main groups: (1) light horses, (2) heavy horses, and (3) ponies. Light horses have small bones and thin legs. Most weigh less than 590 kilograms. Heavy horses have large bones and thick, sturdy legs. Some weigh more than 910 kilograms. Ponies are small horses that stand less than 145 centimetres high. Most ponies weigh less than 360 kilograms.

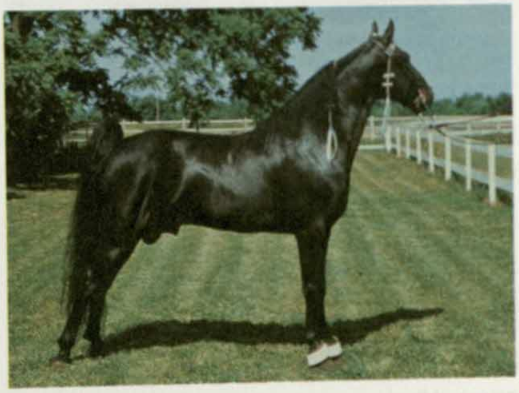
Each of the three main groups of horses has many breeds. However, a single breed may include horses of more than one type. For example, certain kinds of Hackneys are classified as light horses, and other kinds are considered ponies. In addition to light horses, heavy horses, and ponies, there are also a few kinds of wild horses.

Light horses

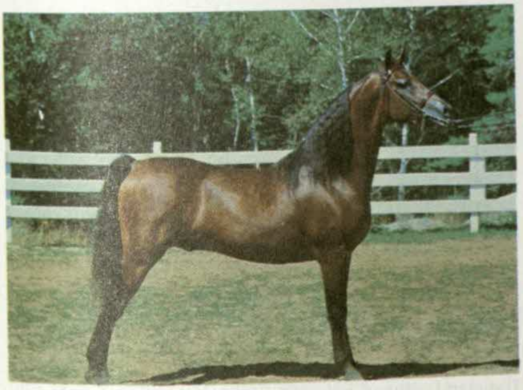
Saddle horses for riding make up an important group of breeds. Many people ride horses for pleasure



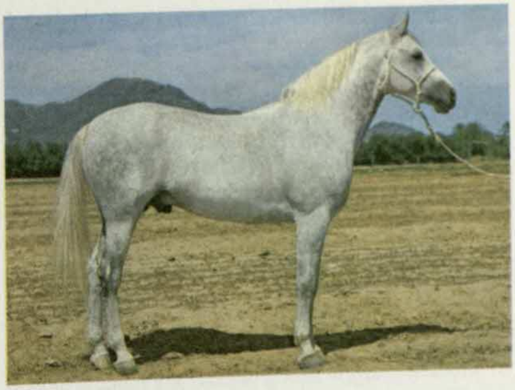
American saddle horse



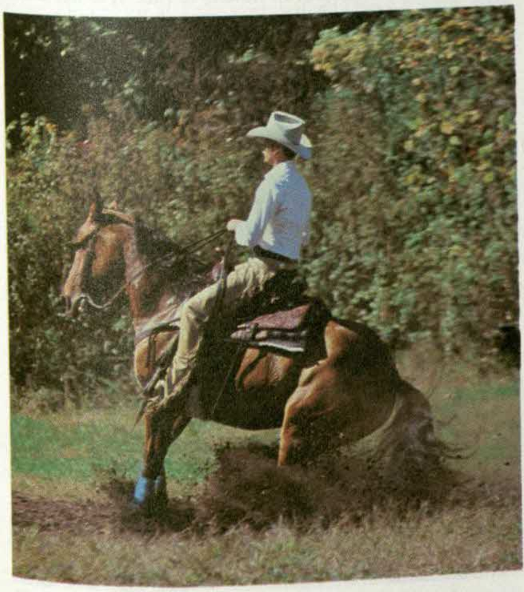
Tennessee walking horse



Morgan



Arab



Quarter horse

or breed them as a hobby. Some riders achieve great skill and compete with other riders in horse shows and sports involving horses.

Popular breeds used for pleasure riding include the strong Arab horse, which is noted for its endurance. Arabs developed this breed for use in the desert. Some experts believe that a handsome and swift breed of horse lived in the Arabian peninsula as long ago as 5000 B.C., at the time when it was a green and fertile land. This is probably the earliest ancestor of the Arab horse.

Early Egyptian monuments, and especially one statue dated between 2000 and 1300 B.C., show a horse with marked Arabian characteristics. Desert tribes passed on the pedigrees of these exceptional animals by word of mouth, and fierce desert warriors regarded the welfare of their horses as a religious duty. As a result, Arab horses increased in numbers and quality, making them superior to other horses in stamina and speed. For hundreds of years, breeders in many countries have brought these horses from Arabia and used them to develop new breeds.

One breed that developed from Arab horses is the thoroughbred. All thoroughbreds can be traced back to three stallions named Darley Arab, Godolphin Barb (sometimes called Godolphin Arab), and Byerly Turk.

Thoroughbred

Standardbred

In the late 1600's and early 1700's, European breeders crossed these stallions with their own horses to produce the first thoroughbreds. Thoroughbreds are the fastest, most highly developed horses in the world. Breeders have used them extensively to give greater size, speed, courage, and quality to other breeds. Thoroughbreds have powerful lungs and strong legs, which makes them especially well-suited for racing. Thoroughbreds are also used for jumping and hunting. In addition, many polo ponies are part thoroughbred.

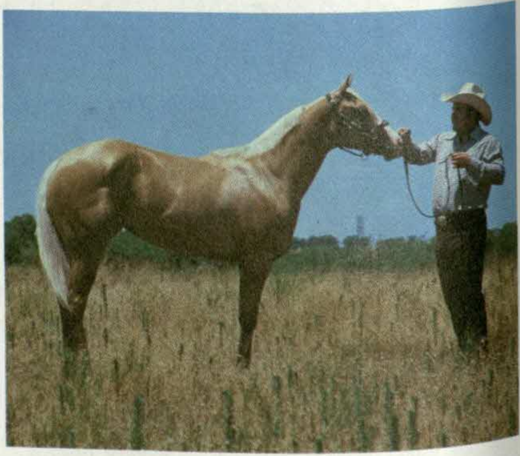
The *grey* (white) Lipizzan horses, or Lipizzaners, come from horses imported into Austria from Spain and Italy during the middle 1500's. The breed takes its name from Lipizza, Yugoslavia, where a stud farm bred these animals. These beautiful show horses have strong bones, short legs, and thick, arched necks. They can make difficult jumps because of their powerful hindquarters. The best-known Lipizzan horses are those trained at the Spanish Riding School of Vienna. These horses perform graceful jumping and dancing feats.

Popular breeds in the United States include the American saddle horse, Tennessee walking horse, Morgan, and quarter horse. The American saddle horse and Tennessee walking horse were developed as mounts that were comfortable to ride. Morgans were first used for pulling carriages and for trotting racing. Quarter horses were bred as sure-footed mounts with good endurance.

Light harness horses, sometimes called *roadsters,* include the Morgan, the Hackney, and the standardbred. The standardbred, also called the American trotting horse, is considered the best horse for trotting racing. Owners train standardbred horses to race at either a trot or a pace.

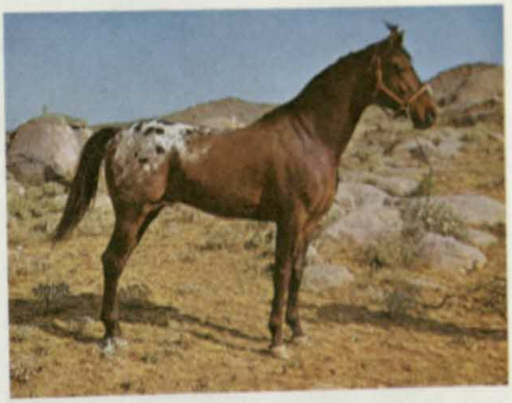
Colour types. Light horses are sometimes grouped according to colour types instead of by breed. Such groups include palominos, albinos, and Appaloosas.

Lipizzaner



Palomino

Albino



Appaloosa

Palominos have a golden coat and a blond or silvery mane and tail. Most of them have white only on the face and on the legs below the hocks and knees. Palominos belong to almost every breed except the thoroughbred. A palomino mare and stallion often produce a *foal* (baby horse) of another colour. Breeders in the United States and Mexico developed the Palomino line.

Albinos. Some breeders use the word *albino* to describe any horse with a white or pale-coloured coat. However, a true albino is an animal that, because of heredity, has no colour in its eyes, hair, or skin. Its offspring also lack colour.

All albino horses have some colour that their offspring can inherit. One kind of albino has a pink skin, ivory coat, white mane, and blue eyes. Another kind has pink skin, a white coat, and brown eyes.

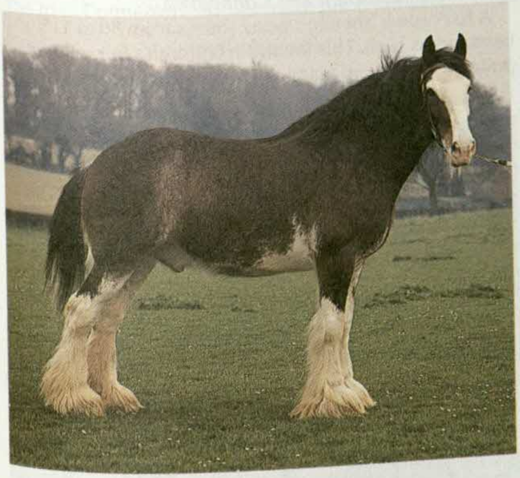
Appaloosas are strictly a separate breed, but some people regard them as a colour type. In fact, they vary greatly in colour. But the vast majority have a white area on the loin and hips with small, round or oval dark spots. Appaloosas are sometimes called *raindrop horses* because of their spots. They also have white-rimmed, humanlike eyes. Black and white stripes cover the hoofs of most Appaloosas.

Spanish adventurers first brought Appaloosas to North America. The Nez Percé Indians of what are now Idaho and Washington bred these horses in the Palouse River region. The name *Appaloosa* comes from the word *Palouse.*

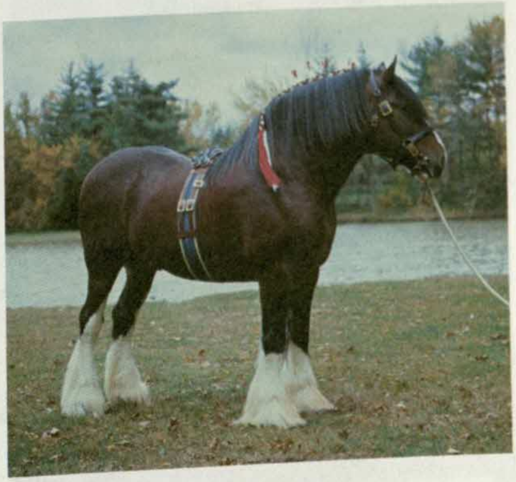
Heavy horses

Draught horses are the tallest, heaviest, and strongest group of horses. They are descended from the primitive forest horses of northern Europe. In the Middle Ages they were used to carry heavily armoured knights into battle. Draught horses once did the heavy work of pulling ploughs and hauling goods wagons. Draught breeds include the shire, Clydesdale, Belgian, Percheron, and Suffolk.

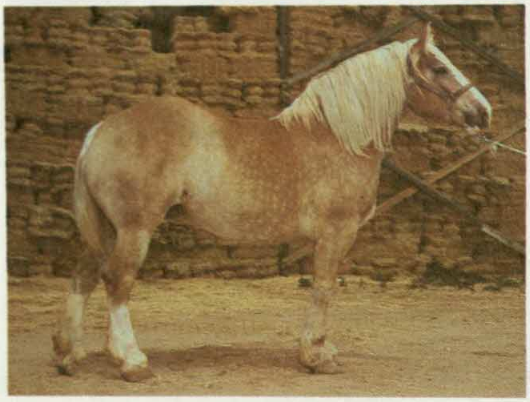
The *shire* is the largest horse. This breed developed in England after King Henry VIII had all horses less than 1.5 metres high destroyed as useless.



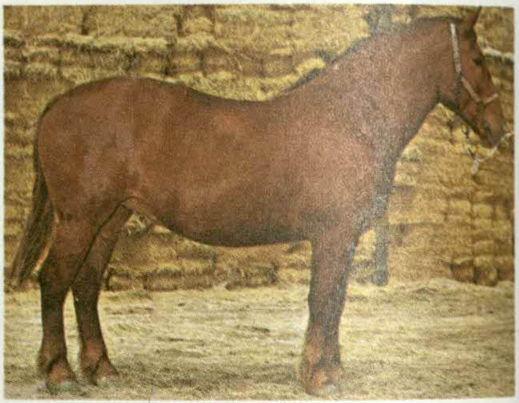
Clydesdale



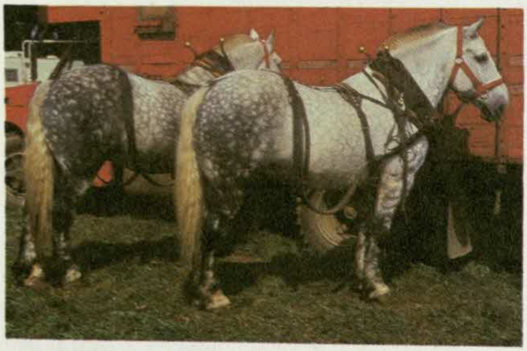
Shire



Belgian



Suffolk



Percherons

The *Clydesdale,* one of the finest draught breeds, has long, flowing hair below the knee and the *hock* (joint on the hind legs). This hair, called "feathers," gives the animals a smart and unusual look. Clydesdales are popular horses for pulling wagons in parades.

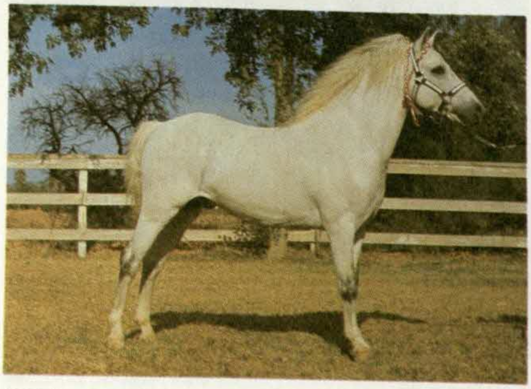
The *Belgian* ranks among the gentlest and strongest horses. Heavy muscles give the Belgian a stout appearance, and the head may seem too small for the huge body. Most Belgians have chestnut or bay-coloured coats. Percherons look much like Belgians but have grey or black coats. These lively animals may be used as general-purpose horses. The *Suffolk,* a smaller, chestnut-coloured horse, makes an ideal draught horse.

Heavy harness horses, also called *coach horses,* weigh less than draught horses and are not as strong. These horses can do light farm work and make good mounts for pleasure riding. European breeders developed heavy harness horses to pull coaches, wagons, and artillery. Breeds include the *Cleveland bay, French coach* (Normand), and *German coach* (Oldenburger). Cleveland bays look like compact, rugged thoroughbreds. They make excellent general-purpose horses for driving, riding, and hunting.

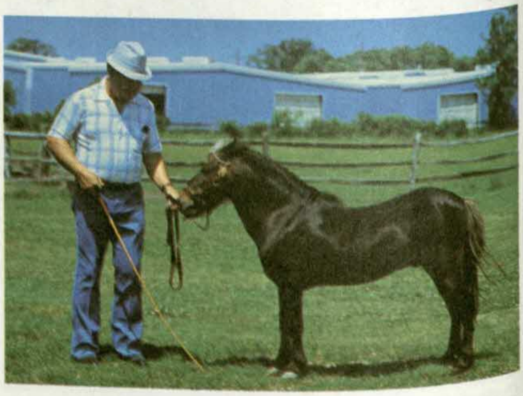
Ponies

Well-trained ponies make good pets for children. Ponies learn quickly and are usually gentle. They are used for pleasure riding and can pull small carts. Most ponies live longer than other horses. Breeds include the *Shetland, Welsh, Hackney,* and *Connemara.*

A full-grown Shetland pony stands from 80 to 115 centimetres high. This favourite children's horse once pulled ploughs and wagons in its native Shetland Is-



Welsh pony



Shetland pony

Hackney pony

Przewalski's horse

lands, north of Scotland. Miners in Wales developed the Welsh pit pony to work in the cramped tunnels of coal mines. This pony is strong and agile enough to carry a rider. The Hackney is one of the largest pony breeds. The Irish Connemara ponies make good jumpers.

Wild horses

Apart from Przewalski's horse and the tarpan, there are other wild horses living in herds, just as their ancestors did. The horses that live in the Camargue district of southern France are just one example. In the United Kingdom, herds of Exmoor, Welsh, and New Forest ponies roam their own particular parts of the country. Dominant stallions collect and look after their bands of mares, mark their territories, and lead their groups from one grazing area to another, just as their wild ancestors did thousands of years ago. Australian *brumbies* and North American *mustangs* follow the same patterns of behaviour. These last two breeds are domestic animals that escaped from their owners and bred in the wild.

The body of a horse

Size. Horse owners measure the height of a horse in *hands,* from the ground to the highest point of the *withers* (ridge between the shoulder bones). A hand equals 4 inches (10.16 centimetres), the average width of a man's hand. A horse that stands 14.2 hands (14 hands and 2 inches) is 58 inches (147.32 centimetres high).

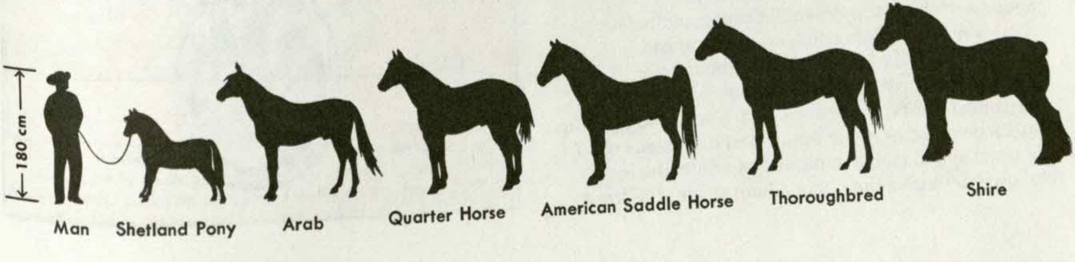
Coat and skin. The horse's body is covered by a coat of hair. A healthy, glowing coat gives a splendid appearance. A thick winter coat grows every autumn and is shed every spring. Horses never shed the hair of the mane or the tail. If the mane and tail become too thick, the horse's owner may pull out some hair to make the horse look better. Pulling the hair does not hurt because the animal has no nerves at the roots of its hair. A horse uses its tail to brush off insects. A horse also has special muscles for twitching the skin to get rid of insects.

Sweat glands on the surface of the horse's body help the animal stay cool. The heavy coats of horses used for fast work, such as racing or polo, should be clipped in winter. The horses can then cool off more easily when they sweat. When the animals are resting, they should be covered with a blanket to keep them warm.

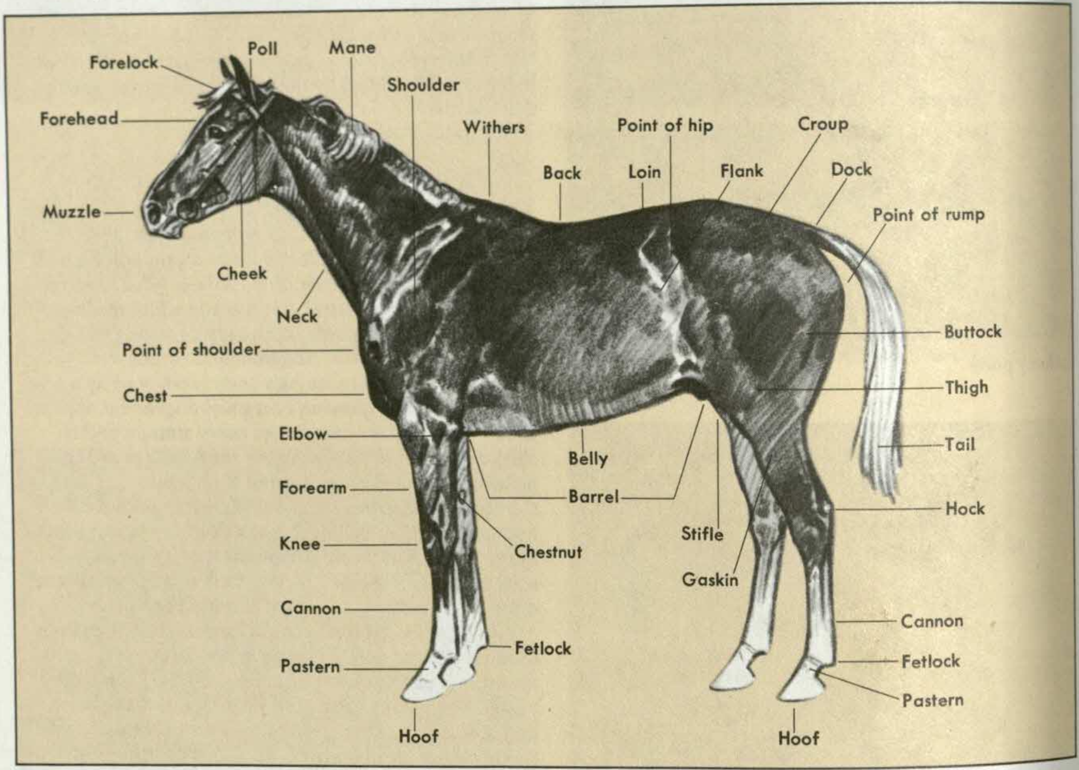
Pinto

The sizes of horses

Horses range in height from less than 1 metre to more than 1.5 metres at the withers. These illustrations show how various breeds compare in height to an average-sized man.



The body of a horse



Horses have many colours, including various shades of black, brown, *chestnut* (reddish-brown), *dun* (yellowish-grey), gold, grey, *sorrel* (yellowish-brown), and white. *Bay* horses have a reddish-brown coat and black *points* (legs, mane, and tail). Many dark bays have brown hair on the back and reddish-brown hair on the flanks, underparts, and face. Chestnut horses may have *flaxen* (pale-yellow) or sorrel manes and tails, but not black points. Many grey horses are born a dark colour and turn lighter as they grow older. Lipizzans and some other grey horses turn white by the time they are fully grown. Adult horses with white coats are generally referred to as greys. *Roan* horses have a yellowish-brown or reddish-brown coat sprinkled with grey or white hairs. *Pintos,* also called *paints,* have a black or dark-coloured coat with large white areas that vary in pattern.

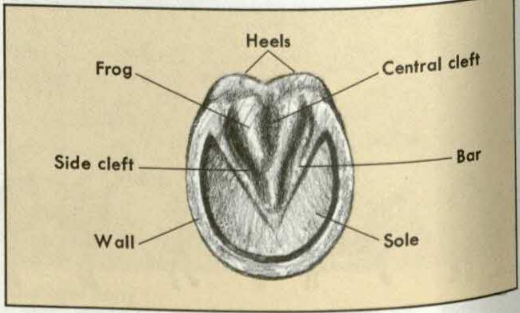
Horse breeders use special terms to describe the markings on a horse's face or legs. The terms include:

Baldface—a mostly white face.
Blaze—a large white patch on the face.
Race—a narrow strip down the centre of the face.
Star—any small white patch on the forehead.
Snip—any small white patch near the muzzle.
Sock—a white patch above the foot.

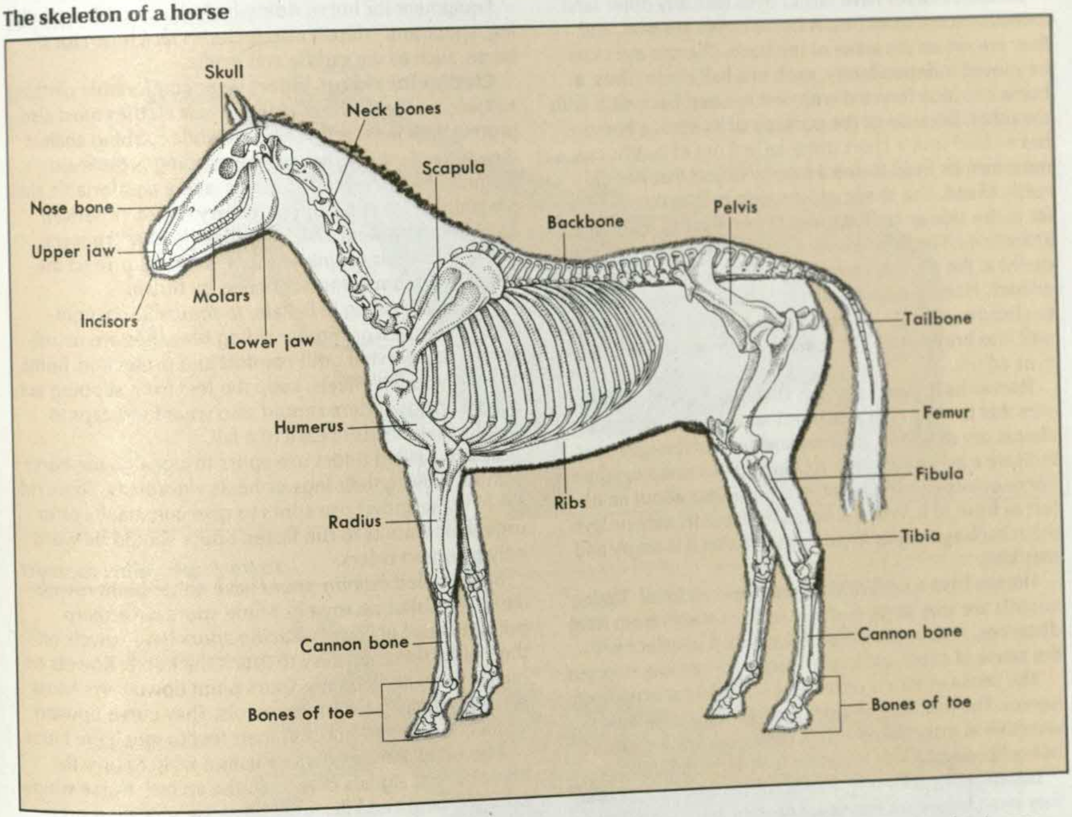
Legs and hoofs. A horse's legs are suited to fast running. Large muscles in the upper part of the legs provide great speed with a minimum of effort. The long, thin lower legs give the horse a long stride. The front legs carry most of the horse's weight. They absorb the jolts when the animal runs or jumps. The rear legs provide power for running or jumping.

Thousands of years of evolution have given the horse feet ideally suited to running. Each foot is in reality a strong toe. Only the tip of the toe, protected by the strong, curved hoof, touches the ground. The remains of what were once two other toes grow as bony strips on the *cannon* bone of the horse's legs. The *frog* (an elastic mass on the sole of the foot) acts like a rubber heel. It helps absorb the jolt when the hoof strikes the ground. The horse's real heel bone is the *hock,* located about halfway up the leg. The hock never touches the ground.

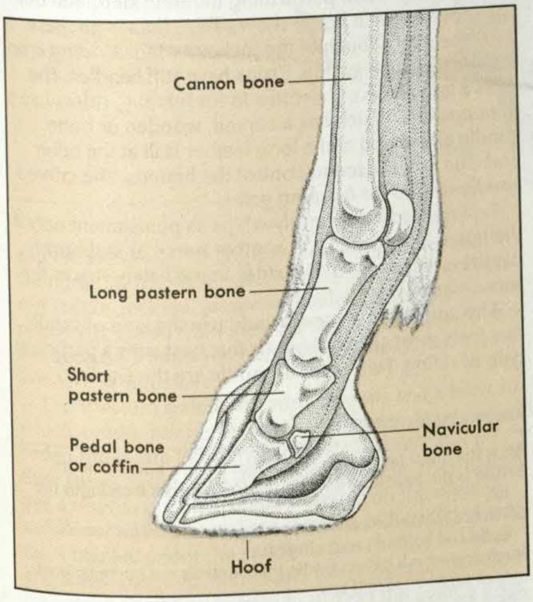
The bottom of a horse's hoof



The skeleton of a horse



The foot of a horse



A horse's foot has a single toe, which is formed by the pastern bones and the pedal bone. A horse walks on the tips of its toes, each of which is covered by a strong, hard hoof.

A horse with a bad fracture of the foot or leg is usually killed because the break causes shock and extreme pain. But certain fractures do not cause much pain and may heal. Veterinary surgeons (or *vets* as they are commonly known) treat such breaks with slings and casts.

Teeth. Most male horses have 40 teeth, and most females have 36. The *molars* (back teeth) grind food as the horse chews. These teeth have no nerves, and they never stop growing. Sometimes the molars grow unevenly and must be filed down so that the horse can chew properly.

An expert on horses can tell a horse's age by counting the number of teeth and checking their condition. Most foals are born toothless but soon get two upper and two lower front teeth. When 4 months old, the horse has four upper and four lower teeth. At the age of 1 year, it has six pairs of upper and lower *incisors* (cutting teeth). At 5 years, a horse has 12 pairs of incisors and is said to have a full mouth. Adult horses have six pairs of molars. Males grow four extra teeth at the age of 5. By the time a horse is 8 years old, the rough grinding surfaces of the bottom incisors have been worn down. The horse has a smooth mouth and is said to be *aged.* Sometimes tiny wolf teeth grow in front of the molars. These teeth interfere with the *bit,* which is the part of a bridle that goes into the horse's mouth. Wolf teeth are usually removed. The bit rests in spaces between the horse's incisors and molars.

Senses. Horses have larger eyes than any other land animals except ostriches. A horse's eyes are oval, and they are set on the sides of the head. The two eyes can be moved independently, each in a half circle. Thus, a horse can look forward with one eye and backward with the other. Because of the position of its eyes, a horse has a blind spot a short distance in front of it. A horse must turn its head to see a nearby object that lies directly ahead. The shape of a horse's eyes makes objects far to the side or back appear to move faster than they actually do. For this reason, a horse may *shy* (move suddenly) at the slightest movement of an object to the side or back. Horses' eyes require a fairly long time to adjust to changes of light. When a horse is moved from a dark stall into bright sunlight, it may appear nervous until its eyes adjust.

Horses have keen hearing. They have short, pointed ears that they can move around to pick up sounds from almost any direction. Certain positions of the ears may indicate a horse's attitude or mood. For example, when a horse points its ears forward, it is curious about an object in front of it. When a horse twitches its ears or lays them back against its head, it shows that it is angry and may kick.

Horses have a well-developed sense of smell. Their nostrils are very large and can pick up scents from long distances. A strong wind and heavy rain interfere with the sense of smell and cause horses to become nervous.

The sense of touch varies among different breeds of horses. The thin skin of most breeds of light horses is sensitive to insects and rough objects. Most breeds of heavy horses are less sensitive to such irritations.

Intelligence. Horses can learn to follow signals, but they must be taught through constant repetition. They also must be encouraged to overcome their fear of unfamiliar objects and situations. Horses have excellent memories and can recall pleasant or unpleasant experiences many years after they occur. See **Animal** (Intelligence of animals).

Life history. A mare carries her foal for about 11 months before giving birth. This period may vary from 10 to 14 months. Foals can stand shortly after birth, and within a few hours they are able to run about. The legs of newborn horses seem much too long for their bodies. As the horse matures, the legs grow more slowly than the rest of the body.

A year-old colt is about half grown. Most horses reach full height and weight by the age of 5. Most horse breeders begin breeding from mares at the age of 3 or 4, and stallions at the age of 2. Most mares have five or six foals during their lifetime, but some of them have as many as 19.

Race horses have their official birthday on January 1, except in the Southern Hemisphere, where it is on August 1. Regardless of their actual birth date, race horses become a year older on their official birthday. This system is used to qualify horses for races that are limited to certain age groups. For example, only 3-year-olds take part in the famous U.S. horse race, the Kentucky Derby. Most of the major *flat races* (races not run over fences or jumps) are for 2- and 3-year-olds. Most horses live from 20 to 30 years.

Riding equipment

Equipment for horse riding includes the rider's clothing, spurs, and whip. It also includes *tack* (gear) for the horse, such as the saddle and bridle.

Clothes for riding. Riders wear comfortable clothing suitable for their type of riding. Their clothes must also protect their legs from irritation while rubbing against the saddle. In many places where riding is the main method of getting around, jeans and a comfortable shirt are probably best for open-country riding. American cowboys often wear *chaps* (seatless leather trousers) that fit over their ordinary trousers. Chaps protect the rider's legs from being scratched by brush.

For leisure riding in Britain, *jodhpurs* (long, tight-fitting breeches) or regular riding breeches are usually worn. They provide both comfort and protection. Boots, or any shoes with heels, keep the feet from slipping out of the stirrups. Riders should also wear hard caps to protect their heads in case of a fall.

Spurs. Skilled riders use spurs to signal to the horse without moving their legs or heels vigorously. Some riders in horse shows use spurs to give commands or to urge their mounts to run faster. Spurs should be worn only by expert riders.

Spurs called *dummy spurs* have either blunt *rowels* (little wheels) or no rowels. Some spurs have sharp points instead of rowels. *Racing spurs* have rowels on the inside to make it easy to touch the horse. Rowels on racing spurs and dummy spurs point downward. Most *dressage spurs* have sharp rowels. They curve upward so that riders need not shift their feet to touch the horse.

The whip. An expert rider uses a whip to give the horse special signals or to train the animal. Horse whips are lightweight and flexible and cause no pain if properly used. Horses learn to respond to signals from a trainer's whip when performing different steps and difficult movements in horse shows. Race horses increase their speed at a touch of the jockey's whip. A *riding crop* may be used like a whip. Crops have stiff handles. The tip is a large loop of rawhide. In fox hunting, riders use a *hunting whip,* which has a curved, wooden or bone handle at one end and a long leather lash at the other end. The lash is used to control the hounds. The curved handle is used for opening gates.

Experienced riders apply whips as punishment only if the horse kicks or bites at another horse or stubbornly disobeys a command. The rider immediately strikes the horse sharply on the flanks.

The saddle. A person should use the kind of saddle that feels most comfortable or that best suits a particular type of riding. Two types of saddle are the *English*

Riding equipment

Bit is the metal part of the bridle that fits in a horse's mouth.

Bridle is the headgear used to control a horse. It includes the bit.

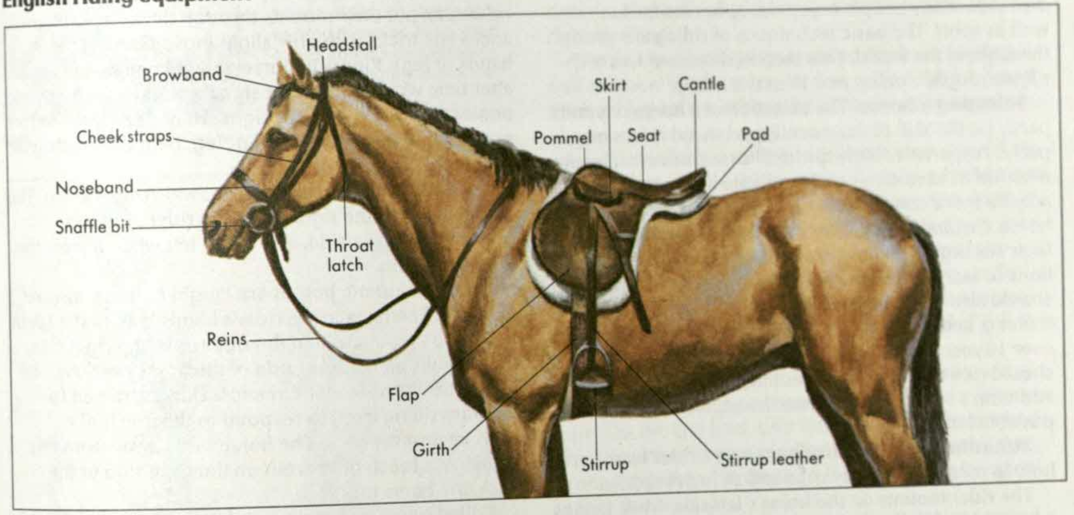
Girth is a leather or canvas strap that fits under the horse's belly and holds a saddle in place.

Hackamore is a bitless bridle that controls the horse by pressure on its nose and jaw.

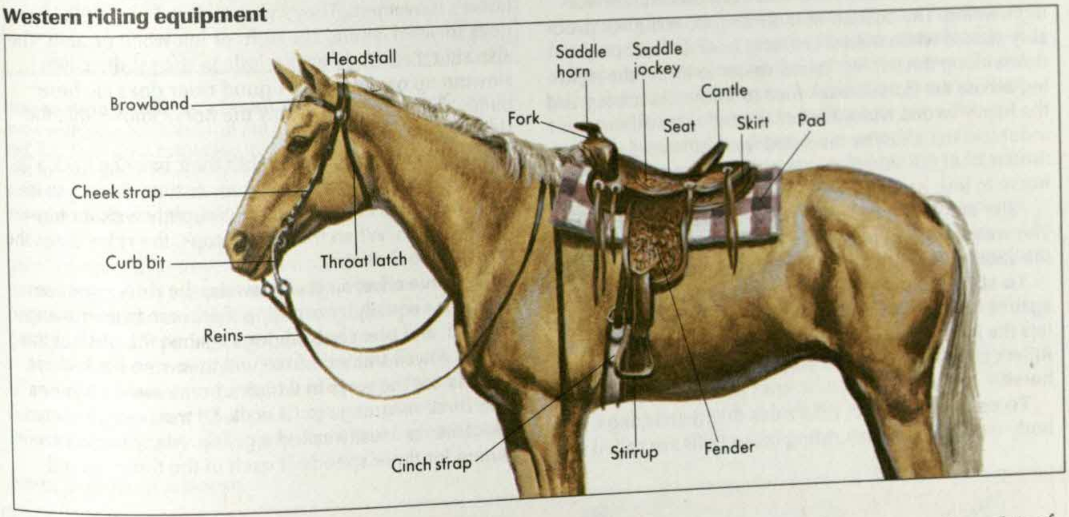
Reins are long, narrow leather strips attached at one end to the bit. The rider holds the other end.

Tack is riding equipment, such as the bridle and saddle.

English riding equipment



Western riding equipment



and the *Western.* The English saddle is padded and comfortable. It is flatter and weighs less than the Western saddle. Jockeys, jumpers, and exhibition riders who need extra speed from their horses use the English saddle because it limits the horse's movements less than a Western saddle does.

The Western saddle has wide stirrups and a *horn,* to which a rope may be fastened. In America, cowboys and rodeo riders use Western saddles. Cowboys may tie their ropes to the horn when roping cattle. They usually use a *double girth* (two saddle straps) on the Western saddle to hold it securely against the pull of roped cattle. A blanket under the saddle keeps the horse's back and sides from becoming sore. Most Western saddles have fleece padding to help to protect the horse's back.

A rider must choose a saddle with great care. A saddle that does not fit properly may cause spinal damage, and saddle and back must be checked regularly.

The bridle is used to control the horse. It consists of straps and metal pieces that fit on the horse's head and in its mouth. The simplest bridle is the *snaffle bridle.* This bridle has a single set of reins, and a jointed bit that is gentle on the horse. The bit of the snaffle bridle pulls on the corners of the horse's lips.

The *double,* or *full, bridle* is used by advanced riders. This type of bridle has a double set of reins, a snaffle bit, and a *curb bit.* The curb bit fits between the horse's teeth on sensitive spaces called *bars.* This bit puts pressure on the horse's lower jaw. A separate set of reins controls each of the bits. The upper reins move the snaffle bit, and the lower reins operate the curb bit. Pressure on the snaffle bit causes the horse to raise its head. Pressure on the curb bit pulls the horse's head down and brings the animal to an abrupt halt. Another kind of bridle, the *Pelham bridle,* combines the snaffle and curb bits into one bit with a double set of reins.

How to ride

The art of riding and managing horses is called *horsemanship.* Many people enjoy riding horses for fun as well as sport. The basic techniques of riding are similar throughout the world. This section discusses two techniques, *English riding* and *Western riding.*

Selecting a horse. The selection of a horse depends partly on the skill of the rider. Experienced riders may prefer responsive, high-spirited horses. But most beginners feel at ease on a gentle, reliable horse. Youngsters may be more comfortable on a pony than on a large horse. *Geldings,* which are male horses that have had their sex organs removed, are easier to control than stallions or mares. In choosing a horse to buy, a person should also consider such factors as the animal's age, training, and physical condition. A well-trained horse over 10 years old is best for a beginner rider. An expert should ride the horse to determine how trained it is. In addition, a vet should examine the animal and check for possible health problems.

Mounting a horse. The first things a rider learns are how to *mount* (get on) a horse and sit in the saddle.

The rider mounts on the horse's left side. Most horses become used to being mounted from the left side during training. The custom of mounting from the left probably started when men wore long swords that hung down along the left leg. It was easier to throw the right leg across the horse's back than to throw the left leg and the heavy sword. Many horses trained to travel on mountain trails can be mounted from either side. Riders mount from the side that is least likely to cause the horse to lose its balance.

After mounting, the rider sits in a relaxed position. The weight should be settled firmly in the *dip* (middle of the saddle). The back is held erect but not stiff.

To start a horse, the rider squeezes both legs against its sides. As the horse moves forward, the rider lets the reins follow the movement of the horse's head. Riders should look where they are going, not at the horse.

To control a horse, riders use their hands, legs, and body weight. In English riding these skills are called the *aids.* In Western riding they are known as *cues.* Skilled riders can put their mounts through difficult performances and tricks with only slight movements of their hands or legs. Riders in horse shows change gaits time after time with no apparent signals. Horses such as polo ponies respond quickly to signs. They start, stop, or turn at a touch of the rider's hand or leg, or at the shifting of weight.

Trainers teach horses to move *away from the leg.* The horse moves to the right when the rider's left leg presses against its side, and to the left when it feels the rider's right leg.

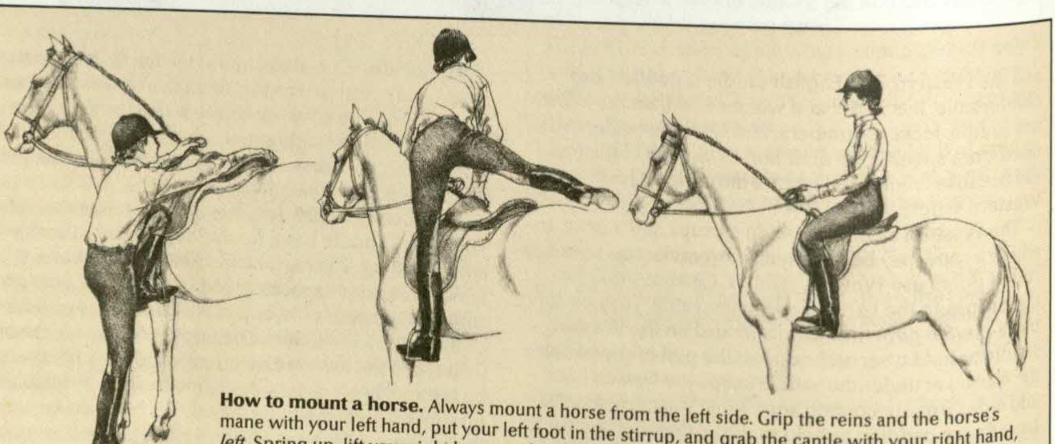
In English riding, horses are taught to move *toward the hand.* The reins in the rider's hands lead to the bit in the horse's mouth. When the rider pulls the right rein, the bit pulls on the right side of the horse's mouth. The horse then turns in that direction. Horses trained for Western riding learn to respond to the touch of the reins against the neck. The horse turns away from this signal. At a touch of the rein on the right side of the neck, the horse turns left.

Skilled riders shift their weight in the direction of the horse's movement. They move forward when the horse goes forward, and to the right or left when turning. They also shift their body back a little in the saddle when slowing up or stopping. A good rider does all these things so smoothly that only the horse knows that the rider has changed balance.

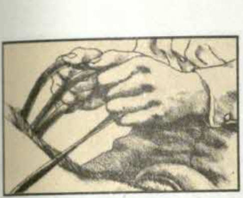
To stop a horse, riders shift their balance back a little in the saddle. Then they squeeze their fingers to increase the pressure on the reins slightly without tugging on them. When the horse stops, the rider eases the pressure on the reins.

To move a horse backwards, the rider squeezes both reins equally, preventing the horse from moving forward, and presses both legs against the girth of the saddle. A well-trained horse will then step backwards.

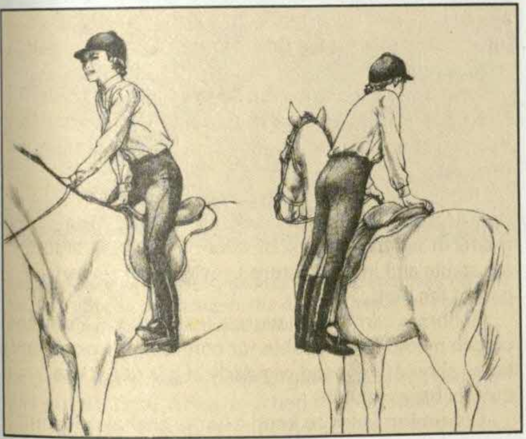
Gaits are the ways in which a horse moves. Horses have three natural gaits: (1) walk, (2) trot, and (3) canter. A fast canter is usually called a gallop. Many horses are trained for three speeds at each of the three natural



How to mount a horse. Always mount a horse from the left side. Grip the reins and the horse's mane with your left hand, put your left foot in the stirrup, and grab the cantle with your right hand, *left.* Spring up, lift your right leg over the horse's rump, and move your right hand to the pommel, *centre.* Sit down gently and put your right foot in the stirrup, *right.*



Holding the reins. The illustration at the left shows how to hold the reins. Keep your hands about 5 centimetres apart and slightly above the horse's withers.



How to dismount from a horse. Grip the reins and the horse's mane with your left hand and put your right hand on the pommel, *left.* Swing your right leg over the horse's rump and bring it next to your left leg, moving your right hand to the cantle, *right.* Balancing your body with your hands, remove your left foot from the stirrup and drop down.

gaits. Trainers also develop artificial gaits in some horses. Horses so trained compete in horse shows and perform in circuses, fairs, and other displays. Artificial gaits include the pace, slow gait, and rack.

Walk is the slowest gait. The horse moves at a speed of about 6 kilometres an hour. It raises one foot after another and puts them down in the same order. The horse keeps its balance by altering its front and back feet, and its right and left feet. For example, the order may be (1) right forefoot, (2) left hind foot, (3) left forefoot, and (4) right hind foot.

Trot is a two-beat gait at a speed of about 14 kilometres an hour. The front leg on one side of the body and the hind leg on the other side hit the ground together. The horse bends its legs more when it is trotting than when it is walking. Trotting-race horses trot around the track while pulling a driver in a *sulky* (two-wheeled cart).

When beginners first ride at a trot, they should hold onto the horse's mane or the saddle until they get used to the motion. On the first beat of a trot, riders raise their body slightly by pushing their feet down on the stirrups. They come down in the saddle on the second beat and then go right up again. This method of riding is sometimes called *posting.*

Canter is a comfortable, three-beat rhythmic riding gait. A horse canters at a speed of 16 to 19 kilometres an hour. On the first beat, one forefoot strikes the ground. Then the other forefoot and opposite hind leg hit the ground together. On the third beat, the other hind foot strikes the ground.

Gallop is a horse's fastest natural gait. Horses gallop in a leaping and bounding motion. On the first beat, a hind foot strikes the ground. Then the other hind foot and opposite forefoot hit the ground together. On the third beat, the other forefoot strikes the ground. Then the horse leaps forward, and all its feet leave the ground. A racing horse runs at an extended gallop. Many experts consider the extended gallop to be a four-beat motion.

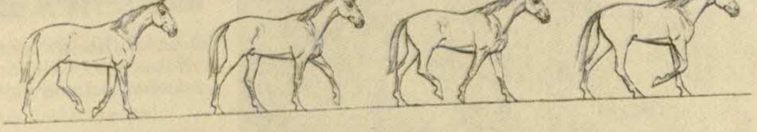
Pace, like the trot, is a gait used in harness racing. When a horse paces, it moves the legs on the same side of the body at the same time. The pace is an uncomfortable riding gait.

Slow gait is a slow, four-beat gait. Four beats of the hoofs can be heard as the horse moves forward.

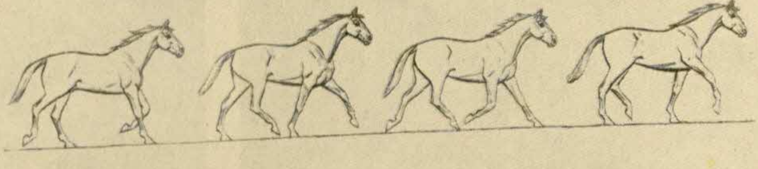
Rack is a fast, smooth, four-beat gait. It resembles the slow gait but is faster. Five-gaited saddle horses are trained to slow gait and rack.

Natural gaits of a horse

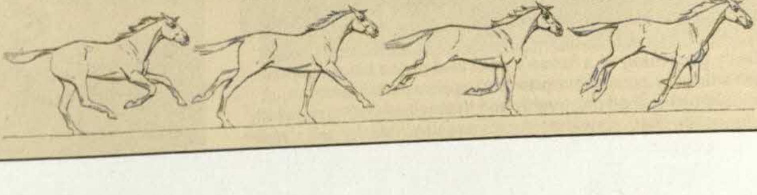
The walk is a four-beat gait. The feet hit the ground as follows: (1) right forefoot, (2) left hind foot, (3) left forefoot, and (4) right hind foot.



The trot is a two-beat gait. The feet hit in the following order: (1) right forefoot and left hind foot and (2) left forefoot and right hind foot.



The gallop is a three-beat gait. The feet hit as follows: (1) left hind foot, (2) left forefoot and right hind foot, and (3) right forefoot.



The stall. A horse should live in a clean, comfortable stall that measures at least 3 metres by 3 metres. The stable should be light, dry, and well ventilated. Clay or finely ground cinders make the best floor, but cement or wooden floors can be used. Bedding spread at least 30 centimetres thick over the floor gives the horse a comfortable resting place. Wood shavings, sawdust, straw, or peat moss make good bedding materials. Horses can sleep standing up and often doze while standing with their eyes wide open.

Food. A horse needs food at least three times a day. Its stomach is small for the size of its body, and its digestive system is designed to cope with an almost continuous intake of food. The horse has a very large bowel, and food is digested slowly. But when its stomach is two-thirds full, food is passed to the bowels at the same rate as it enters the mouth. A horse's stomach holds about 17 litres of food, whereas the stomach of an average man holds just under a litre.

Horses eat grass, grain, and hay. When a horse eats grain or hay, it gathers its food with its lips. When a horse eats grass, it bites off the blades close to the ground. Horses chew their food slowly and thoroughly. They do not chew a cud as do cows and deer.

Hay for horses should be placed in a net or on a *rack* (wooden frame). A *manger* (open box) holds the grain. A 450-kilogram horse that works three or four hours a day needs about 6.5 kilograms of hay—2 kilograms in the morning and the rest at night. A horse should never eat mouldy or dusty hay, or hay that contains coarse sticks, thorns, or rubbish. *Timothy* (a type of grass), or timothy mixed with clover or alfalfa, makes the best hay.

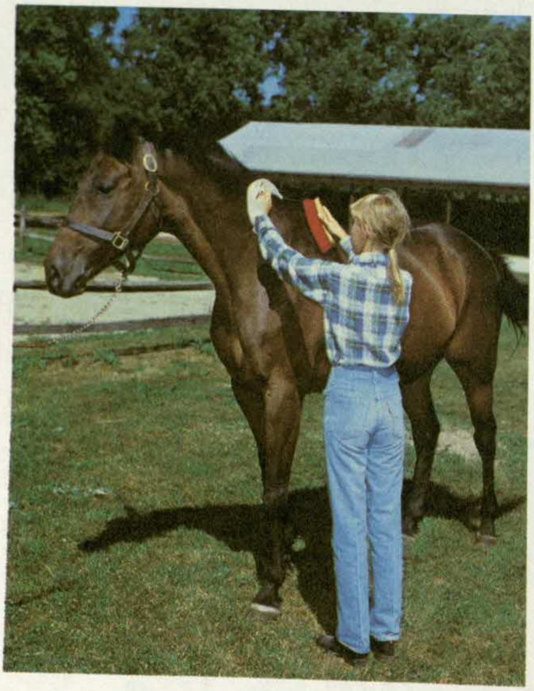
Horses like oats more than any other grain or hay. But they will eat oats too quickly unless they have some hay first. Working horses eat from 4 to 11.5 litres of oats, or a mixture of oats and bran, every day. The exact amount depends on the animal's size and condition, and the amount of exercise it gets. A third of the feed should be given in the morning, a third at noon, and the remaining third at night.

Most horses require from 38 to 45 litres of fresh, clean water daily. A horse should not be permitted to drink large amounts of water when it is hot or before it begins hard exercise.

Horses need salt for good health because their bodies lose salt when they sweat. A horse eats about 57 grams of salt daily. A box of salt or a solid salt block in the stable and in the pasture provides this important part of the diet.

All horses carry some worms inside them. There are certain medicines available for controlling worms, and a horse should be dosed regularly. If it is not, it can quickly become unfit.

Grooming helps to keep a horse healthy and improves its appearance. Horses kept in a stable should be groomed daily with a rubber currycomb, body brush, hoof pick, and mane and tail comb. Long sweeping brush strokes in the direction of the growth of the hair



Daily grooming of a horse's coat and mane helps maintain the animal's health and improves its appearance. The coat should be brushed thoroughly and then wiped with a soft cloth, *above.* The mane should be combed to untangle the hairs, *right.*

Cleaning a horse's hoofs is part of the daily care that the animal should receive. A hoof pick should be used to remove dirt and stones and other objects from the hoofs, *above.*

Medical care of a horse includes periodic examinations by a vet. As part of an examination, the doctor checks the condition of the animal's teeth and mouth, *above.*

help to give the coat a healthy glow. Brushing removes dirt and dandruff. Areas touched by the saddle and girth, and the regions behind the heels and in the hock depressions, need special brushing. A thorough wiping with a soft cloth should follow the brushing. The hoof pick removes dirt and stones and other objects from the feet.

Horses that are left outside during the winter develop a layer of grease on the skin to provide protection from rain and snow. Such horses should not be groomed. But mud should be removed from the back and stomach before putting on the saddle and bridle. Otherwise, the tack will rub, and make the horse's back sore.

Shoes protect the feet of horses that run or work on roads and other hard surfaces such as race tracks. Light shoes, weighing about 230 grams and having only a few nails, make the best shoes for most horses. Some riding horses wear shoes weighted in the toes to help them raise their feet high. Race horses wear light shoes that may wear out after a few races. Shoes for wear in winter or for high mountain trails have cleats that help keep the horse from slipping on ice or snow.

Medical care. Horses should be examined by a vet at least once or twice a year. They should be vaccinated against tetanus, influenza, and other diseases. When necessary, they should receive medicine to expel worms. Sometimes, a horse's teeth must be *floated* (filed down to remove sharp edges).

Horse owners can prevent many medical problems by feeding and bedding the animals properly, keeping them and their living quarters clean, and exercising the horses daily. Owners should watch for any changes in the condition or behaviour of their horses and call a vet if a horse appears ill. Signs of illness include loss of appetite, lack of vigour, mucous or bloody discharges from the eyes or nose, swellings or sores on the body, and hot legs or feet. A fast or slow breathing rate or pulse rate may also be a sign of illness. Normally, a resting horse breathes from 8 to 16 times per minute and has a pulse rate of from 30 to 40 beats per minute.

A horse's legs and feet easily become diseased if not cared for properly. Some common diseases of the legs and feet include *thrush, navicular,* and *laminitis.* Thrush is an infection of the frog. It can be prevented by providing clean, dry bedding for a horse. To treat thrush, vets apply medication to the affected frog. Navicular is a disease of the foot bone that causes a horse's legs to become stiff and sore. It is treated with corrective shoeing and drugs. Laminitis, also called *founder,* is an inflammation of the foot. It causes lameness, hot feet, and increased pulse rate. Laminitis is treated by applying medication and soaking the foot in warm water.

Horse shows and sports

Horse shows and sports involving horses include a variety of events that test the speed, strength, and other abilities of the animals. Success in these events also depends on the skill of the riders or drivers. Horse shows and sports have increased greatly in popularity during the 1900's. They are enjoyed by millions of people throughout the world and include local, national, and international competitions.

The Olympic Games have three kinds of *equestrian* (horseback riding) sports: (1) jumping, (2) dressage, and (3) eventing. The International Equestrian Federation regulates the Olympic equestrian events. It also regulates the world championships in *driving,* an event for harness horses and drivers. More than 60 nations belong to the federation.

This section describes horse shows, jumping, dressage, and eventing. *World Book* has separate articles on the sports of fox hunting, trotting racing, horse racing, polo, rodeo, and steeplechasing.

A jumping course consists of different types of obstacles that the contestants must clear. The course shown above includes such standard obstacles as a stone wall and parallel bars.

A well-performed jump requires harmony between the rider and horse. For example, the rider must adapt to the horse's movements and, as shown above, lean forward for the jump.

Horse shows have three main types of competitions: (1) performance, (2) breeding, and (3) *equitation* (horsemanship). In performance competition, the horses and riders demonstrate and are judged on various skills. For example, a show may include jumping, five-gaited riding, or driving events. In breeding competition, all the horses in the event must be of the same breed. They are displayed without saddles. The judges rank the horses on *conformation* (physical qualities) and decide which ones best represent the breed. In equitation competition, the contestants ride their horses around a ring. They are judged on their riding style and control of the horse.

Some horse shows are restricted to only one breed of horses. Others include events for many breeds. Shows may be held indoors or outdoors and may last from a few hours to a week or more.

Showjumping. In showjumping competitions, the contestants ride across a specially designed course that has obstacles for the horses to leap over. The course may include high jumps, wide jumps, and two or more jumps set close together. The courses vary in difficulty, depending on the level of the competition. The contestants in showjumping competitions receive *faults* (penalties) for falls, knocking down part of an obstacle, *refusals,* and other errors. A refusal occurs when the horse will not jump over an obstacle. After three refusals, the horse and rider are eliminated from the competition. The contestant with the fewest faults wins the event. In some showjumping events, the contestants are timed. In case of a tie for first place, the contestant who completes the course in the shortest time wins.

The main kinds of showjumping competitions include (1) Nations' Cup, (2) puissance, and (3) Grand Prix. In Nations' Cups, teams from different countries compete. In most cases, each team consists of four riders and their horses. The three best scores of each team are added to determine the winning team. Puissance events consist mainly of high jumps. The contestants who complete the course without any faults or with equal faults participate in a jump-off. In the jump-off, the number of obstacles is reduced, but the remaining obstacles are raised or widened. The contestants may have several jump-offs, until all except the winner fail to clear the obstacles. Grand Prix competitions are part of the Olympic Games. All contestants complete the course once, and then the top two or more riders participate in a jump-off. In case of a tie for first, the contestant who completes the course in the shortest time wins.

Dressage. In dressage competitions, the riders guide their horses through a series of movements at the walk, trot, and canter, using mainly leg and seat signals. The horse's movements should be smooth, precise, and graceful, and the rider's signals should not be visible to the spectators. Dressage tests take place in an arena measuring 60 metres by 20 metres.

The cross-country event is the most strenuous part of a type of equestrian competition called *eventing.* The contestants must ride over rough terrain, crossing streams and other obstacles, *left.*

Dressage competition consists of a series of smooth, graceful movements performed by the horse in response to signals by the rider. These signals should not be seen by the spectators.

Special dressage movements include the *passage, piaffer,* and *pirouette.* A passage is a rhythmic, elevated trot in which the horse slowly moves forward. A piaffer resembles a trot, but it is performed without any forward, backward, or sideward movement. A pirouette is a circle that the horse makes by pivoting its forelegs and one hind leg around the other hind leg.

In dressage competitions, the series of movements must be performed in a specific order. In most cases, the contestants are judged by two or more officials who sit in various places around the ring. Each judge gives a contestant points for the performance of each movement and penalties for errors.

Eventing is often called the *Three-Day Event* because most major competitions take place during a three-day period. The contestants first compete in a dressage event. They then participate in a speed and endurance (cross-country) event. They ride over a course that may be more than 16 kilometres long and includes rough terrain and such obstacles as brush hedges, rail fences, and streams. The contestants receive penalties for falls, refusals, and failure to complete the course in the allotted time. Lastly, a showjumping competition is held. The results from the events of the three days are added, and the contestant with the fewest penalties wins.

Eventing is probably the most challenging equestrian event. It tests the endurance, obedience, jumping ability, and other qualities of the horse and the skill and daring of the rider. The cross-country event is very strenuous.

Breeding horses

Raising horses for racing, driving, and other sports involves careful breeding and training. It is an important industry in the United States. California, Illinois, Kentucky, and Texas, and many other states have large breeding farms that raise horses.

Breeding horses. On *stud* (breeding) farms, stallions and mares are carefully selected for mating on the basis of their ancestry and physical qualities. Breeders of race horses also consider the racing records of the animals. An owner of a champion racing stallion may earn very large amounts of money in *stud fees* by using the horse for breeding purposes. A stud fee is a sum of money paid to a stallion's owner for the use of the stallion to sire a foal. But, breeders can never be completely certain of producing a colt or filly of champion quality.

Most breeders mate their mares to a stallion in spring. The mares give birth about springtime the following year. People who breed race horses want their foals to be born as soon as possible after January 1 because the foals will be considered yearlings the following January. A foal that is born early in the year has more time to grow and develop before it races as a 2-year-old.

A foal stays with its mother for the first six months after birth. The owner then *weans* (separates) the foal from its mother and puts it out to pasture with other foals.

Breeding horses is an important industry in many countries. On breeding farms like the one on the left, experts breed and train horses for racing, trotting, and other sports. This farm is in the United States.

A newborn foal is cared for by its mother. The mare nurses the foal for the first six months after birth. The owner then *weans* the foal by separating it from the mother and putting it out to pasture with other foals.

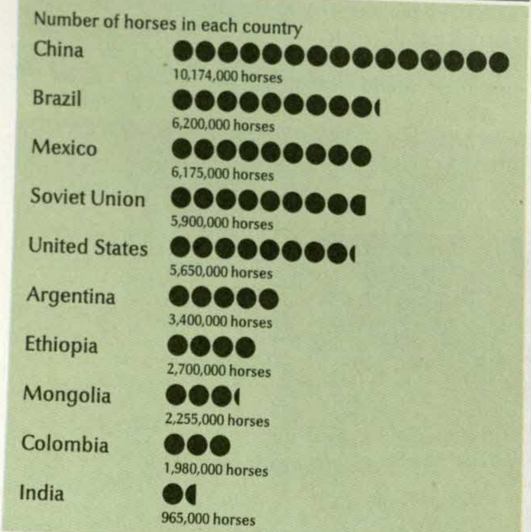
People who breed purebred horses enter their foals in the *registry* of the association for the particular breed. A registry is an official record that lists a horse's sire and dam and other information. Horses that appear in a breed registry are called *registered horses.* Many countries have breed associations and registries. Nations that are well known for breeding horses include Argentina, Canada, France, New Zealand, the United Kingdom, and the United States.

Training horses requires great skill and patience. Expert trainers handle horses gently but firmly and teach them slowly. Soon after birth, a foal learns to accept handling by human beings. Some trainers begin to accustom a foal to a halter almost immediately. Others do not halter-break foals until they are several months old. After a horse is 1 year old, the trainer gradually accustoms it to having a saddle on its back. Then the horse is mounted and ridden a few steps. Most horses that are trained slowly and patiently do not buck when they are mounted for the first time.

A harness horse is also trained in gradual steps. The horse is first taught to respond to signals from long reins, which are held by a person who walks behind the animal. Later, the horse is taught how to pull a light carriage or trap.

After a horse has learned to follow the signals of a rider or driver, it is trained for a certain sport. For example, thoroughbred race horses learn to run when a starting gate swings open. *Starting stalls* (enclosed starting positions in which the gates spring open) are used for all flat races. But organizers of *steeplechases* (horse races over fences or jumps) still rely upon a simple starting tape. Trotting racing horses learn to trot or pace behind a moving starting gate that is attached to a car.

Leading horse-raising countries



Figures are for 1991, prior to the breakup of the Soviet Union.
Source: Food and Agriculture Organization of the United Nations.

Training a colt to lead. A colt learns to *lead*—that is, to follow a person who guides it with a strap—by being led around a ring behind its mother. The colt follows naturally.

Prehistoric paintings of horses have been found in many caves in Europe. The painting shown above, from the Lascaux Cave in southwestern France, is about 17,000 years old.

Origins of the horse. Scientists believe that the earliest ancestor of the horse was a small animal about 25 to 50 centimetres high. They call this animal *Eohippus* (dawn horse) or *Hyracotherium.* It lived about 55 million years ago in what is now North America and Europe.

These prehistoric horses had arched backs and snoutlike noses. They looked more like racing dogs than like the straight-backed, long-faced modern horse. They had four toes on their front feet and three toes on their hind feet. Each toe ended in a separate small hoof. Large, tough pads kept the toes off the ground. These pads bore the animal's weight.

The next important ancestor of the modern horse was *Mesohippus* (middle horse). It lived about 35 million years ago. It averaged about 50 centimetres in height and had long, slender legs. Each foot had three toes, of which the middle toe was longest. About 30 million years ago, it gave way to a new horselike creature, *Miohippus.* This animal stood from 60 to 70 centimetres tall, and its middle toe was longer and stronger than that of its ancestors.

Horselike animals continued to develop, and *Merychippus* (ruminant or cud-chewing horse) appeared about 26 million years ago. It grew about 100 centimetres high. It also had three toes on each foot. The side toes were almost useless, but the centre toe grew long and strong. It ended in a large, curved hoof.

By about 3 million years ago, horses probably looked somewhat like modern horses. They grew larger than their ancestors. The side toes on their feet became short bones along the legs, leaving the strong centre toe with its hoof to support the animals. The teeth also changed, becoming better fitted for eating grass.

Scientists are uncertain as to where horses originated. Fossils show that during the Ice Age horses lived on every continent except Australia. Great herds wandered throughout North and South America. Then, for some unknown reason, they disappeared from the Western Hemisphere.

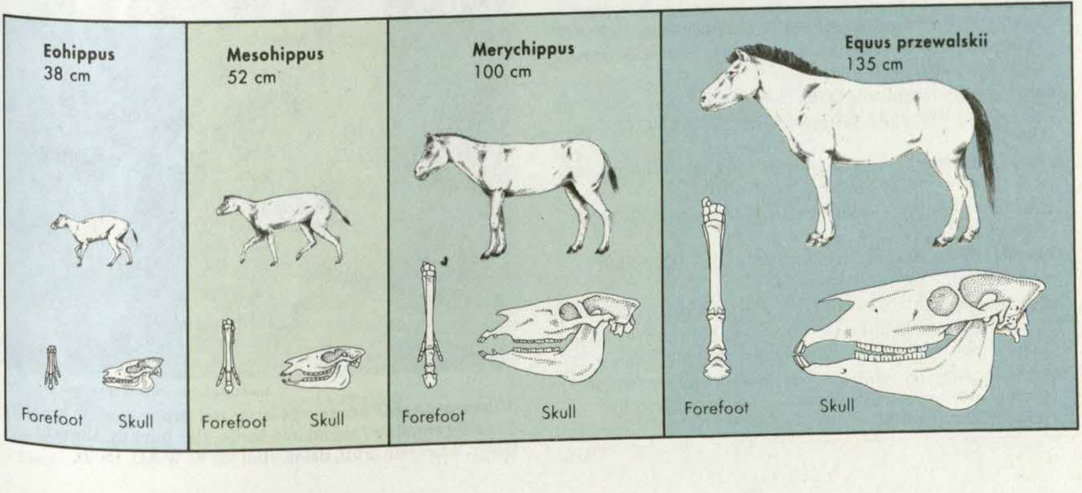
People tame the horse. Early humans hunted horses and ate their meat. No one knows who first tamed horses and trained them for riding. Scientific discoveries at the ancient city of Susa in southwestern Asia show that people rode horses over 5,000 years ago.

Stone tablets show that the Hittites trained horses for sport and war about 1400 B.C. The Assyrians, about 800 B.C., hunted lions in two-wheeled chariots drawn by a pair of horses. Tapestries show early Persians playing a kind of polo. The early Greeks and Romans were expert riders and used horses for racing and other sports. Greek and Roman soldiers rode horses in battle. The Greeks wrote about horsemanship as early as 400 B.C. We still follow their principles of riding.

In 1066, William the Conqueror used mounted knights to invade England. The English then began to breed large, powerful war horses that could carry a man wearing a heavy suit of armour. During the 1300's, after armies began using gunpowder, swift, light steeds

The development of the horse

The illustrations below show some of the ancestors of the modern horse. The earliest ancestor, *Eohippus,* lived about 55 million years ago. Various horselike creatures gradually developed over millions of years, changing in size and other body features. For example, the many-toed feet of early horses developed into the single-toed hoofs of today's horses.



The Metropolitan Museum of Art, New York, U.S.A.

Ornamented horses are led by a man paying tribute to his king. This piece of wall relief of the 700's B.C. comes from the palace of the ancient Assyrian ruler Sargon II, near Mosul, Iraq.

Famous horses in history and legend

Al Borak carried Muhammad from earth to the seventh heaven, according to Muslim legend.

Bucephalus could be ridden only by Alexander the Great, who founded the city of Bucephala about 326 B.C. in honour of his beloved horse.

Cincinnati, a great black charger, carried General Ulysses S. Grant during the American Civil War.

Clever Hans, who lived in the early 1900's, was a famous "talking" horse that solved arithmetic problems.

Comanche, a cavalry horse, was the only survivor of U.S. Lieutenant Colonel George A. Custer's "last stand" in 1876. **Vic,** Custer's horse, died in the battle.

Copenhagen carried the Duke of Wellington to victory in the Battle of Waterloo in 1815.

Diomed won the first English Derby at Epsom Downs, in 1780.

Eclipse, an English thoroughbred foaled in 1764, was the ancestor of many modern thoroughbreds.

Incitatus was made a priest and consul by the Roman Emperor Caligula about A.D. 40. This horse had an ivory manger and drank wine from a golden pail.

Iroquois, in 1881, became the first American-bred horse to win the English Derby.

Marengo, a white stallion, was ridden by Napoleon in his defeat at Waterloo in 1815.

Pegasus was the great winged horse of the Muses (nine goddesses in Greek mythology). See **Pegasus.**

Reckless, a small Korean racing mare, served as ammunition carrier for a U.S. Marine platoon during the Korean War (1950-1953). The mare was made a sergeant and received a medal for bravery under fire.

Sleipnir, the grey horse of Odin, chief god in Norse mythology, was said to have eight legs and be able to travel on land or sea.

Shergar, the race horse who won the 1981 Epson Derby, was kidnapped in 1983. He was never recovered.

Silver, the white horse ridden by the Western hero the Lone Ranger.

Traveller, a spirited grey gelding, carried General Robert E. Lee during the American Civil War.

Trigger, a palomino, was ridden by film cowboy Roy Rogers.

Trojan Horse, a legendary wooden horse built by the Greeks, helped them capture the city of Troy during the Trojan War.

Xanthus was the horse of Achilles. He was supposed to have predicted his master's death, after being scolded by the mighty Greek warrior.

began to replace the large mounts of the knights as war horses.

From the late 1500's onward, breeders developed improved stocks of horses. An important factor in this was the introduction of the Arab horse into many European countries. France had had Arabs since the late 600's. In Britain, the first Arab horses arrived with knights returning from the Crusades in the 1100's. In the 1600's, breeders took a new strain of Arab to Britain and used them as the basis of the thoroughbred. In the 1700's King Louis XV of France founded an important breeding centre called the Pompadour stud. Later, Napoleon ordered the importation of more than 200 Arab stallions and 30 mares to improve the French stock even more. The first Arab breeding centre in Germany was founded in Württemberg in 1817. Today, German Arabs are bred mainly at Marbach. Breeders in the Soviet Union imported their first Arab horses in 1930.

The first European colonists found no horses in North America. Christopher Columbus had brought horses with him on his second voyage to the New World. But most American Indians did not know about horses until Spanish conquerors brought them to Mexico in 1519. Horses that the Spanish explorers left behind probably became the ancestors of the American wild horses.

The American Indians, especially the tribes of the western plains, began to use horses in about 1600. Indians rode horses to hunt buffalo and used them in battle.

Horses played an important part in the development

The Metropolitan Museum of Art, New York, U.S.A.

A European war horse was large and strong enough to carry a heavily armoured knight into battle. This print by Albrecht Dürer, a German artist, dates from the early A.D. 1500's.

Cars began to replace horse-drawn carriages during the early 1900's. Horses lost importance in transportation as the use of motor-driven vehicles became widespread.

and exploration of North America. The pioneers who settled the West rode horses and used them to pull their covered wagons. Mounted soldiers fought in the American Revolution and in the American Civil War.

In the 1800's, horses performed a variety of tasks. Miners used them underground to pull wagons full of coal. Horses pulled trains on short stretches of railway, and they also pulled *trams* (public transport vehicles) in many cities and towns before the invention of electricity. Stage coaches and the pony express were the fastest methods of communication until the invention of the telegraph and telephone.

Horses in the 1900's. With the development of railways, tractors, trucks, and cars, horses became less useful. During World War II (1939-1945), most armies gave up cavalry horses.

Scientific classification. Horses belong to the horse family, Equidae. They are classified as genus *Equus*, species *E. caballus.*

Study aids

Related articles in *World Book* include:

Kinds of horses

Bronco
Mustang
Przewalski's horse
Shetland pony
Tarpan

Members of the horse family

Donkey
Mule
Onager
Zebra

Diseases of horses

Distemper
Glanders
Heaves
Mange
Spavin

Sports

Derby
Fox hunt
Horse racing
Kentucky Derby
Olympic Games (table: Equestrian)
Polo
Rodeo
Steeplechasing
Trotting

Other related articles

Animal (Intelligence of animals)
Bonheur, Rosa (picture)
Bot fly
Centaur
Cowboy
Harness
Hoof
Horse fly
Pegasus
Saddle
Ungulate

Outline

I. Kinds of horses
  A. Light horses
  B. Heavy horses
  C. Ponies
  D. Wild horses
II. The body of a horse
  A. Size
  B. Coat and skin
  C. Legs and hoofs
  D. Teeth
  E. Senses
  F. Intelligence
  G. Life history
III. Riding equipment
  A. Clothes for riding
  B. Spurs
  C. The whip
  D. The saddle
  E. The bridle
IV. How to ride
  A. Selecting a horse
  B. Mounting a horse
  C. To start a horse
  D. To control a horse
  E. To stop a horse
  F. To move a horse backwards
  G. Gaits
V. Care of a horse
  A. The stall
  B. Food
  C. Grooming
  D. Shoes
  E. Medical care
VI. Horse shows and sports
  A. Horse shows
  B. Showjumping
  C. Dressage
  D. Eventing
VII. Breeding horses
  A. Breeding horses
  B. Training horses
VIII. Horses in history

Questions

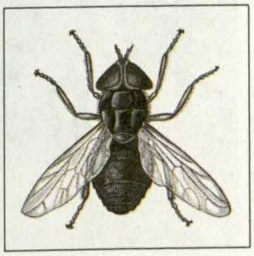
What does a *hand* mean in measuring a horse?
What are the three kinds of equestrian sports in the Olympic Games?
What are the horse's three natural gaits?
Why do horses need salt in their diet?
What did the earliest known ancestor of the horse look like?
How do you start and stop a horse when riding?
Why do owners sometimes cover horses with blankets?
How many teeth does a full-grown horse have?
What are the *aids* or *cues*? How are they used?
Which are the strongest horses?

Horse bean. See **Broad bean.**

Horse chestnut. See **Horsechestnut.**

Horse fly is a name for certain types of flies that live near water in pastures, fields, and forests. The adult male horse fly feeds on flower pollen and nectar. The female bites and sucks the blood of horses and other livestock, as well as people.

The female horse fly lays eggs in bunches on plants that grow in wet soil or hang over water. The wormlike *larvae* (young) develop in the mud and eat worms and other small animals. The eyes of the male horse fly are large and touch at the top of the head. The female's eyes are smaller and do not touch.



Horse fly

Certain female horse flies carry diseases, such as anthrax and tularaemia. They transmit the infection from one animal to another when they bite. Horse flies are difficult to control. Oil sprays and pyrethrum sprays have been used successfully to kill the adult flies.

Scientific classification. The horse fly is a member of the order Diptera and belongs to the horse fly family, Tabanidae.

See also **Fly** (with picture: A horse fly's eyes).

Horse latitudes are regions noted for their lack of winds. Two belts of calm air extend around the earth at about 30° north and south latitude. The regions may have received their name because many horses died on ships delayed there by the lack of wind. Or the name may have come from a Spanish sailing term that called the winds there unpredictable, supposedly like a female horse. The horse latitudes lie between the belts of the trade winds and the prevailing westerlies. The name is also given to belts of light rainfall at about 25° north and 30° south latitude.

Horse nettle. See **Solanum.**

Horse racing is a popular sport based on the speed of horses and the skill of jockeys. Horse races have been held since ancient times, and millions of people throughout the world enjoy them today. Racing fans thrill to the sight of colourfully dressed jockeys on sleek horses galloping around a track toward the winning post.

One of the features of horse racing is the chance to win money by betting on horses to be *placed,* that is, to finish first, second, third, or fourth, depending on the number of runners. People may also try various combinations of bets.

There are two main kinds of horse racing that are popular throughout the world. In one kind, jockeys ride horses round flat courses. Such races are called *flat races.* The other kind of racing is called *steeplechasing* and *hurdling,* known in the United Kingdom collectively as *National Hunt* racing. *Point-to-point* racing is a type of steeplechase for amateur riders. In steeplechasing, horses ridden by jockeys race over obstacles. This article discusses flat racing. For information on steeplechases, see the *World Book* article on **Steeplechasing.**

Race horses

Most race horses are *thoroughbreds*—that is, horses whose ancestry can be traced back to any of three Arab stallions. One of these stallions, named the Byerly Turk, was taken to England in the late 1600's. The other two, called the Darley Arab and the Godolphin Barb, were taken there in the early 1700's. Arab horses are known for their speed, and these three stallions were carefully bred with English mares to produce swift, strong race horses.

Thoroughbreds weigh from 450 to 545 kilograms. They stand from 155 to 165 centimetres tall from the ground to the *withers,* the highest part of a horse's back.

Thoroughbreds are not allowed to race until they are 2 years old. In the Northern Hemisphere, the age of a thoroughbred is automatically calculated from January 1 of the year in which it is born. Thus, all thoroughbreds born during the same year have the same birthday. This method of determining age simplifies the basic grouping of race horses according to age. Most thoroughbreds that race are 2, 3, 4, or 5 years old. Breeding programmes are planned so that the horses are born early in the year. In the Southern Hemisphere, the age of a thoroughbred is calculated from August 1.

Various terms are used to classify thoroughbreds according to age and sex. A newborn thoroughbred is called a *foal* until its first birthday, when it becomes a *yearling.* A male is a *colt* from its second birthday until it reaches the age of 5. It is then called a *horse.* A female is

Race horses gallop into the first turn of the track as the crouching jockeys manoeuvre for position. Thousands of excited racing fans cheer for their favourite horses.

a *filly* from the age of 2 until the age of 5, when it becomes a *mare*. A male parent is a *sire*, and a female parent is a *dam*. A male horse that has been castrated is called a *gelding*.

Jockeys

Jockeys control the horses in a race. The skill of a jockey in handling a horse can determine whether the horse wins the race.

Horses are required to carry a certain weight in races. In flat racing, jockeys are small. The horses usually carry weights of between 44 and 63 kilograms, so the lighter a jockey is, the more rides he or she is likely to get. A young jockey learning his profession under the care of a trainer is called an *apprentice*. Apprentices can claim a weight *allowance* to make up for their inexperience. In the United Kingdom the allowance can be 3 kilograms until they have ridden 10 winners, 2 kilograms for up to 50 winners, and $1\frac{1}{2}$ kilograms until they have ridden 75 winners. The weight that each horse carries in a race is carefully controlled according to the rules applying to that particular event.

A jockey's equipment includes a saddle, a whip, boots, a safety helmet, and a special jacket and cap. The jacket and cap, called *silks*, are provided by the owner of the horse. The colours and the colour arrangement of silks identify the owner. Each owner's silks differ from those of other owners. Silks are also called *colours*.

At the races

Types of horse races. Most horse races are run over distances ranging from 1.2 to 4 kilometres. However, the course of the famous Grand National steeplechase race, held near Liverpool, in England, is 7.2 kilometres long. The distances of horse races are also expressed in units called *furlongs*. A furlong equals 201 metres.

The owners of the horses that finish first, second, and third in a race receive prize money. Prize money determines the many different types of races throughout the world. Races include sweepstakes, plates, and purses. Within these divisions are selling and claiming races, and also weight-for-age and handicap races.

A *sweepstake* is a race in which the prize money, or part of it, comes from the owners of the horses entered. It is made up of fees, forfeits, and other subscriptions, and sometimes also from other sources. All this money is added together and distributed among the first three prize-winners, with the owner of the first horse past the post receiving the largest share.

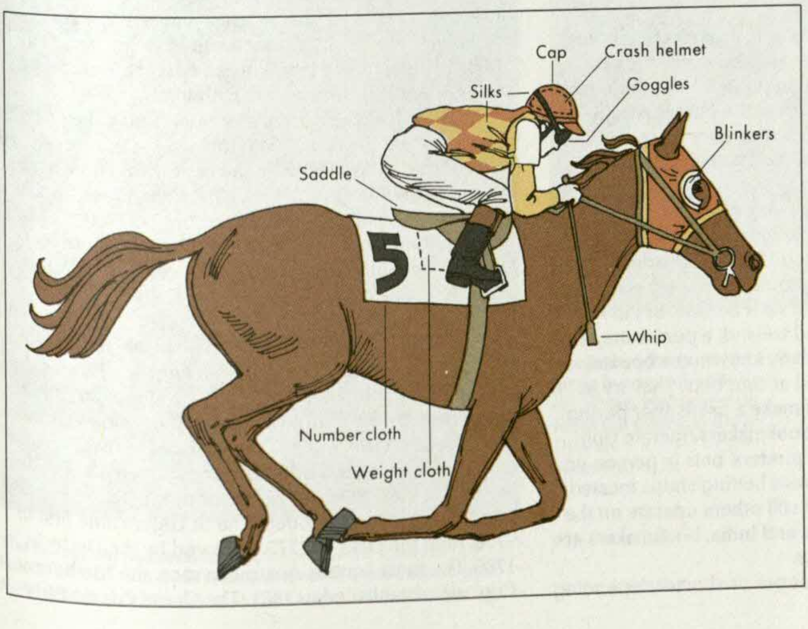
Most famous horse races are sweepstakes. They include the Epsom Derby in England, the Irish Sweeps Derby in Ireland, the Melbourne Cup in Australia, and the Kentucky Derby in the United States.

A *plate* is a race that guarantees prizes of a definite value to the winners. The money comes from the race fund of that particular course. If contributions from the horses' owners fall short of the guaranteed sum, the race fund has to make up the difference.

A *purse* is a race in which the whole of the prize money is put up by the race course. The owners make no contribution at all.

Selling races are run by the lowest types of horses. As soon as the race is over, the winner is put up for sale by auction. In a *claiming race*, any runner can be "claimed" after the race. That is, it can be bought by another owner for a previously advertised amount.

Within the different distance categories in both flat racing and jumping there are various kinds of restrictions. The top contests in most countries are *weight-for-age races*. In these, the weights carried by each runner are dictated by its age. A young horse will carry less weight than older and stronger rivals. In such races a concession is also made to *fillies* (females under five years old), which are a little weaker than their male counterparts. In some other races the weights to be carried depend upon certain conditions, such as the quality of previous races won.



A jockey's equipment includes a saddle and, under it, the weight cloth in which strips of lead are placed to adjust the weight carried, the number cloth, a whip, goggles, and crash helmet. This horse is wearing blinkers to help his concentration.

In a *handicap race,* the weight carried by each individual horse is adjusted by an official handicapper. His purpose is to give each runner an equal chance of winning. Weight is added by inserting flat lead weights into pockets in a piece of cloth called a *weight cloth.*

The racecourse. Racecourses vary from country to country in shape, composition, and size. In Great Britain, for example, no two of more than 60 racecourses are identical. Some are left-handed, some right-handed, and some courses are quite straight. Some courses are flat, some undulate. Since 1989, Britain has had two all-weather courses where racing takes place on a sand-based artificial surface. These are at Lingfield Park in Surrey and at Southwell in Nottinghamshire. All other British courses have a grass surface, known as the *turf* in racing circles. Some of these courses are quite small, others are vast. This variety obtains also in Australia and the other four main European racing countries—France, Germany, Ireland, and Italy. Far Eastern courses, such as Fuchu in Tokyo, resemble American courses. These tend to be flat, left-handed, and oval, and most of them have a dirt surface.

Betting. There are two basic ways of betting on horses: with a totalizator or with a bookmaker, although methods and habits vary from country to country. The *totalizator* ("Tote") system, also called *pari-mutuel,* means that all the money wagered on horses to win a race is combined in a fund called a *pool.* After the race, the money in the pool is divided among all those who have backed the winner. The *odds* (amount expressed as a ratio) are based on the proportion of money in the pool that was placed on the winning horse, after deductions have been made for administrative costs and, in most countries, for the racecourse and general financing of the sport.

A *punter* (person who bets) has various types of bets to choose from. He or she may bet on a horse to win or to be placed. Betting on a horse to win *and* to be placed is called *betting each way.* In Britain, a bet on either of two particular horses to finish first and second is called a *forecast.*

After the race, the *dividend* (return) is declared. This includes the *stake money* (the amount originally wagered). If a punter won 5 British pounds after putting a 1 pound bet on a horse, that means the punter would have made a profit of 4 pounds, the extra 1 pound being the stake money. The odds in that case could be expressed as 4 to 1.

In the United States, the major racecourses use the totalizator system of betting. In most countries the totalizator is the only betting system. Examples include Hong Kong and Japan where the amounts of money wagered every day are huge compared with Europe. But in Australia, Great Britain, India, and Ireland, a punter may also bet with a *bookmaker* (popularly known as a *bookie*). Bookmakers set the odds and accept bets. They try to set odds that enable them to make a profit after paying the winning punters. Some bookmakers operate from offices from which they take punters' bets in person or by telephone. Others work from betting shops located in main shopping areas. And still others operate on the racecourse itself. In Australia and India, bookmakers are found only on the racecourse.

A bookmaker's odds get longer or shorter depending on the amount of money bet on each horse. The punter may bet at the odds that the bookmaker is showing at the time the bet is made, or else at the *starting price* (SP), which is the official odds declared on the course after the race has ended.

The horse with the shortest odds in any race is the *favourite.* Horses at very long odds are *outsiders.* These are two of the simplest terms used in a sport that has a language of its own. This includes an elaborate hand sign language called *tic-tac,* used by bookmakers on the course to send information to each other.

The start. Before a race, the jockeys are weighed with their equipment. This *weighing out* procedure is supervised by a course official. The weight of each rider and the equipment must match the weight that is assigned to the jockey's horse.

About 30 minutes before a race, the horses are taken to the *paddock,* a fenced-in area where they are saddled. The jockeys then go to the paddock and, on a signal from an official, they mount their horses. The horses parade past the grandstand and enter their assigned stalls in the starting gate. Another official, the *starter,* presses a button. A bell rings and all the stall doors open at the same instant. The horses lunge from the gate, and race toward the winning post.

Officials called *stewards* may disqualify a horse and change the results of a race if they spot any rule violations. Immediately after a race, to make sure the horses have not been drugged or received illegal medication, urine and blood tests are performed on the winner and others chosen at random. In addition, the jockeys and their equipment are weighed again to confirm that the horses carried the correct weight.

History

Early horse racing. Horse racing probably began about the time that horses were first domesticated. The earliest records of horse races date back to about 1500 B.C., when chariot races were held in eastern Europe and northern Africa. The Olympic Games in ancient Greece first featured chariot races in 680 B.C. Races between horses with riders were added to the games in 648 B.C. Horse racing later spread to what became Asia Minor, France, Germany, India, and Italy.

The Romans, who controlled what is now the United Kingdom from the A.D. 40's to the early 400's, introduced horse racing there. Through the centuries, English monarchs and members of the nobility owned race horses. As a result, horse racing is sometimes called the *sport of kings.* King James I established a racing centre at Newmarket, Suffolk, England, and races began to be held there about 1619. Newmarket is still a centre of horse racing today.

Charles II was the monarch most closely linked with the early history of horse racing in England. He was the only reigning monarch to ride the winner of an official horse race. By the middle of the 1700's, racing was in a disorganized state. In 1750, the Jockey Club was formed in England, to try and bring order out of chaos. Toward the end of the 1700's, the oldest of the so-called English Classic races were founded. The St Leger came first in 1776, then the Oaks in 1779, followed by the Derby in 1780. The most famous Australian race, the Melbourne Cup, was established in 1861. The Grand Prix de Paris was first held in 1863 in France, and the Irish Sweeps Derby in Ireland in 1866. Steeplechasing over a specially built course (instead of open country) first took place in England at Bedford in 1811.

During the mid-1800's, Turf administrators made strenuous efforts to organize racing properly. They aimed to have the sport controlled efficiently and free from any hint of corruption.

Over the last 100 years, techniques have changed considerably. Today's jockeys ride very differently from the upright stance adopted by their counterparts in the late 1800's. Training methods are more sophisticated, racecourses are far better maintained, and horses are more specialized.

Racing today. Since the end of World War II (1939-1945), dozens of race horses on the flat and over jumps have won worldwide fame. In 1955 and 1956, the Italian horse Ribot was unbeaten in 16 races, winning the Prix de l'Arc de Triomphe in each of those years. Nijinsky, trained in Ireland, won the English Triple Crown (the Derby, St Leger, and Two Thousand Guineas) in 1970, the first horse to do so for 35 years. Arkle, another Irish-trained horse, proved himself to be probably the greatest steeplechaser ever, winning the Cheltenham Gold Cup three times in the mid-1960's. Brigadier Gerard was beaten only once in 18 races.

The French horse Sea Bird II was never beaten, winning the Derby and the Arc de Triomphe with great ease in 1965. The great Australian horse Tulloch won 36 of his 53 races. Red Rum was the only horse ever to win three Grand Nationals (1973, 1974, and 1977). The grey steeplechaser Desert Orchid became one of the most popular racehorses in living memory by winning a succession of big races, including the Cheltenham Gold Cup in 1989.

Related articles in *World Book* include:

Derby	Hippodrome
Gambling	Horse
Grand National	Kentucky Derby

Horseback riding. See Horse (How to ride).

Horsecar. See Tram and trolleybus.

Horsechestnut is the name of a group of trees and shrubs native to Europe, Asia, and North America. There are about 15 species of horsechestnuts. The most common of these species is the *European horsechestnut,* which first grew in the Balkans region in southeastern Europe. Nowadays, the European horsechestnut is planted in much of the Northern Hemisphere as a shade tree and is admired for its showy flowers. Species of horsechestnut native to North America are called *buckeyes.* The large seeds of these trees look like the eye of a *buck* (male deer).

The flowers of horsechestnuts range from white to rose and yellow. They open in clusters in late spring or summer. The leaves consist of five to nine leaflets attached at a common point. The seeds grow in large, leathery capsules and measure up to 5 centimetres in diameter. They are bitter-tasting and poisonous if eaten raw. However, American Indians once cooked the seeds for food. In the United Kingdom, children play with the shiny brown seeds of the horsechestnut in a game known as *conkers.*

The wood of these trees is used for furniture and decorative ware and also for making charcoal.

Scientific classification. The horsechestnut makes up the genus *Aesculus* in the horsechestnut family, Hippocastanaceae. The European horsechestnut is *A. hippocastanum.*

See also **Tree** (Familiar broadleaf and needleleaf trees [picture]).

The European horsechestnut, *above,* bears spikes of tiny flowers in May. The thick branches make it a good shade tree. North American horsechestnut trees are called *buckeyes.*

The horsechestnut has dark green leaves and white flowers, *above.* Horsechestnut seeds are large and brown. They are enclosed by spiny coverings, *right.*

Horsefly. See **Horse fly.**

Horsehair worm is a long, thin worm that looks like a coiled hair from the mane or tail of a horse. It is sometimes called a *hairworm.* There are about 200 kinds of horsehair worms. Most of them live in damp soil and in the shallow water of lakes, ponds, and streams. They may grow as long as 70 centimetres, but most are shorter. The majority of horsehair worms are black, brown, or cream coloured.

Female horsehair worms lay thousands of eggs. A larva hatched from an egg forms a small, round structure called a *cyst.* The cyst may be eaten by a beetle, cricket, or grasshopper. The larva may then emerge from the cyst and penetrate beyond the insect's intestine. The young worm lives there as a parasite. The larva may also use a special organ to bore its way into the body of an insect. After the worm reaches maturity, it leaves the insect and lives freely in the water.

Scientific classification. Horsehair worms make up the phylum Aschelminthes, belonging to the class Nematomorpha.

Horseheal. See **Elecampane.**

Horsemanship. See **Horse** (How to ride).

Horsepower is a unit used to express the *power* (rate of doing work) of an engine in the imperial system of measurements. The term *horsepower* was first used by the Scottish engineer James Watt. He used it to compare the power of steam engines to the power of horses (see **Watt, James**). The term was later used to express the power of such devices as car engines, jet engines, electric motors, and nuclear reactors. One horsepower is defined as 550 foot-pounds of work per second, or 33,000 foot-pounds of work per minute. One *foot-pound* is the work needed to lift one pound one foot. The metric unit of power is the *watt.* One horsepower equals 745.7 watts. See **Foot-pound; Watt.**

If an engine lifts a 550-pound object to a height of 2 feet in 1 second, it is working at a rate of 1,100 foot-pounds per second ($550 \times 2 \div 1 = 1{,}100$). This engine is delivering 2 horsepower ($1{,}100 \div 550 = 2$). If a 150-pound man climbs to a height of 88 feet, he does 13,200 foot-pounds of work ($150 \times 88 = 13{,}200$). If the man makes this climb in 1 minute (60 seconds), he is working at a rate of $\frac{4}{10}$ horsepower ($13{,}200 \div 60 = 220$; $220 \div 550 = \frac{4}{10}$). A person who is accustomed to hard work can work at a rate between $\frac{1}{10}$ and $\frac{1}{8}$ horsepower continuously during an 8-hour day.

The power of an engine was measured in indicated horsepower, or brake horsepower. It is now usually measured in watts.

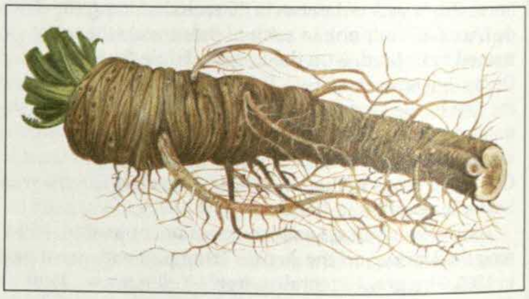
Indicated horsepower is a measurement of the power produced inside the cylinders of an engine. The power in foot-pounds per minute is first calculated by multiplying together the average pressure on the pistons, the area of each piston, the length of the piston's stroke, the number of power strokes per minute, and the number of cylinders in the engine. This power must be divided by 33,000 to give the engine's indicated horsepower.

Brake horsepower is sometimes called *effective horsepower,* because it is the amount of power available at the engine's shaft. Brake horsepower is measured by a *dynamometer.* This instrument measures the engine's speed and the *torque* (amount of twist) exerted by its shaft. It is lower than indicated horsepower because friction in the engine wastes part of the power produced in the cylinders.

See also **Air conditioning** (Capacity of air conditioners); **Power** (In physics).

Horseradish is a herb whose root is used to make a sharp food relish. The plant is native to Europe and western Asia. It has many long leaves and a large root. People grate the root to prepare it for use. They preserve the grated pieces in vinegar to prevent loss of the chemical compound that gives horseradish its biting taste. The horseradish root retains its sharp taste until it is ground. Whole roots retain their sharp taste for long periods.

When workers harvest horseradish, they remove the side roots. These roots are used for the following year's crop. Farmers take the side roots for planting in the spring.



The root of the horseradish has a biting taste.

Scientific classification. Horseradish belongs to the mustard family, Cruciferae. It is *Armoracia rusticana.*

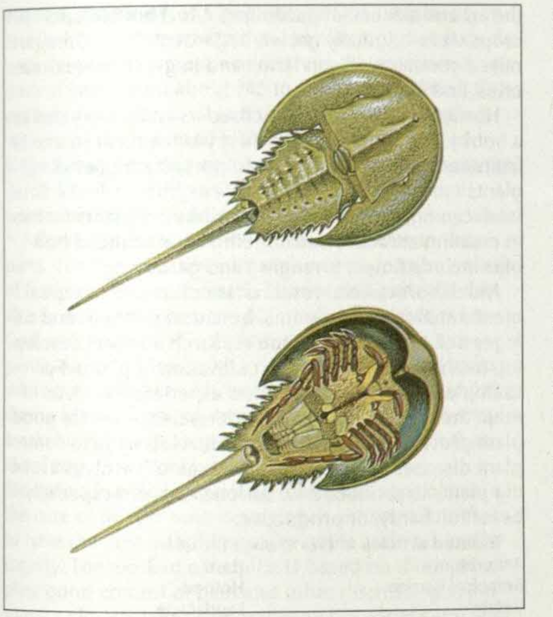
Horseshoe. See **Horse** (Shoes); **Superstition** (Kinds of superstitions).

Horseshoe crab is a large marine animal with a shell shaped something like a horse's hoof. The horseshoe crab is sometimes called the *king crab.* However, it is not related to the commercially important *red king crab,* which is actually a crab. Horseshoe crabs are the only surviving members of a large group of animals that appeared on earth millions of years ago. The closest living relatives of horseshoe crabs are scorpions and spiders.

There are four species of horseshoe crabs. The largest grows to about 61 centimetres long and lives along the eastern coast of North America. The other three species inhabit the coastal waters of southeast Asia and the Philippines.

The horseshoe crab's body consists of two "hinged" parts, the *prosoma* and the abdomen. The prosoma is the part of the body covered by the shell and includes the head. The shell has openings for the animal's eyes. The mouth and legs are located beneath the shell on the lower surface of the prosoma. Horseshoe crabs have six pairs of legs. The front pair have pincers and are used to capture prey. The other five pairs of legs are used for walking.

The horseshoe crab's abdomen has six pairs of flattened, platelike structures. The reproductive organs are in the front pair of these plates. The remaining plates each carry approximately 150 soft gills by which the ani-



The horseshoe crab has a shell that resembles a horse's hoof. The bottom illustration shows the underside of the animal. The crab has six pairs of legs. The front pair have pincers used to capture prey. The other legs are used for walking.

mal breathes. A jointed spine sticks out from the end of the abdomen. The horseshoe crab uses this "tail" as a lever for digging.

The horseshoe crab lives in marine coastal waters. It feeds at night on worms and small molluscs, such as clams, that it digs up from sand and mud. Horseshoe crabs mate in the spring. The female carries the male on her back to shore, where she digs several holes in the sand. The female lays from 200 to 1,000 eggs in each of the holes, and the male then fertilizes the eggs.

Scientific classification. Horseshoe crabs belong to the family Limulidae in the order Xiphosura. They are included in three genera: *Limulus, Tachypleus,* and *Carcinoscorpius.* The largest and most common species is *L. polyphemus.*

Horseshoe Falls. See Niagara Falls.

Horseshoe pitching is a game played by throwing horseshoes at a stake. Two, three, or four persons can play at a time. Players score points by getting the horseshoes close to or around the stake.

Rules. Regulation horseshoes are flat, U-shaped pieces of iron with a *calk* (small toe) at the closed end and at each tip. A shoe may not be more than 18 centimetres wide and 19 centimetres long. It must not weigh over 1.2 kilograms, and it must have no more than 9 centimetres of space between the calks at the open end.

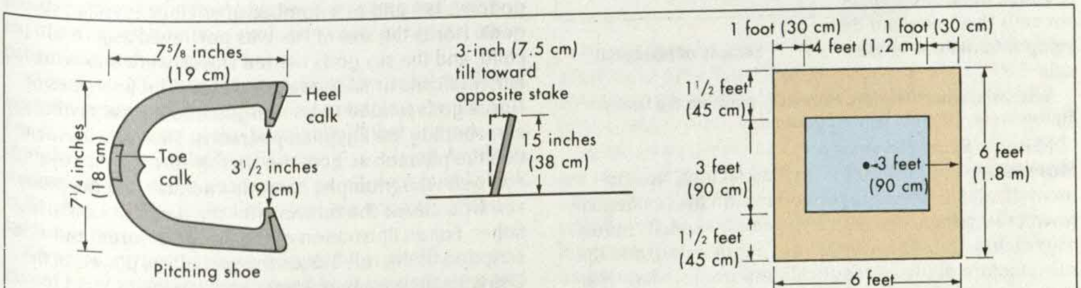
A *pitching court* is about 1.8 metres wide and about 15 metres long. Within this area, two steel or iron stakes 2.5 centimetres in diameter are driven or anchored into the ground 12 metres apart. Each stake stands 38 centimetres high in a *pitching box* that is 1.8 metres square. Each pitching box has an area of clay, soil, or sand, in which the horseshoes land.

If two or three people play a game, they compete individually. If four play, two people make up each team. Players take turns throwing the horseshoes. A player throws two shoes each turn. Men pitch from a distance of 12 metres from the stake. Women and juniors (players under age 17) throw from a distance of 9 metres. Players pitch horseshoes with an underhand motion. Fingertip control gives the shoe a flip or turn so the open end faces the stake as the shoe lands.

Scoring. A *ringer* is a shoe that encircles the stake so that a straight edge can touch both tips of the shoe without touching the stake. A ringer scores 3 points. A shoe that comes to rest within 15 centimetres of the stake scores 1 point. A *leaner* (a shoe that leans against the

Horseshoe pitching

Horseshoe pitching is played on a rectangular court that has a stake set in a pitching box at each end. Players stand behind a foul line at one end of the court and pitch two horseshoes at the stake at the other end. The diagram below shows the dimensions of a regulation court and a horseshoe.

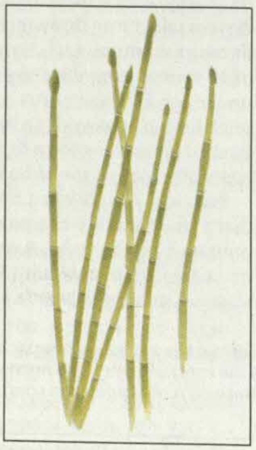


stake) is also worth 1 point. There are two main systems of scoring horseshoe pitching contests, *cancellation* and *count-all.* In cancellation, a game usually consists of 40 points. If opposing players throw ringers or shoes that land equally close to the stake, the shoes cancel each other. Points are scored by counting the ringer or shoe closest to the stake that is not tied by the opposing player. A count-all game normally consists of *25 innings* (50 shoes thrown by each player). In a count-all game, all ringers and horseshoes within 15 centimetres of the stake are scored according to their point values.

History. Horseshoe pitching originated in Roman army camps about A.D. 100. The game has long been popular in the United States and Canada, but for many years it had no set rules. In 1914, a group of men set up standards of play and equipment, and the popularity of the game increased.

Horsetail is a plant with a hollow, jointed, and usually grooved stem. The stem contains silica, an abrasive material (see **Silica**). The horsetail is sometimes called *scouring rush* because it was once used to polish metal. Horsetails have a range of medicinal properties.

Most horsetails are small plants. The stalks of some species resemble tiny trees. In prehistoric times, some plants of this family grew to be large trees. The plant grows from perennial creeping rootstocks. It bears no flowers, and it is more closely related to ferns than to flowering plants. Horsetails reproduce by means of both spores and sex cells. The spores are contained in small cones at the tips of the stem or its branches, or sometimes on a separate stalk. The plant releases the spores, which germinate in damp places and grow into tiny plants. These plants produce male and female sex cells that unite and develop into mature horsetails.



Shoots of horsetail

Scientific classification. Horsetails make up the family Equisetaceae. They are genus *Equisetum.*

See also **Plant** (Horsetails).

Horsham (pop. 107,300) is an English local government district in West Sussex centred on the residential town of Horsham. The district is mainly rural. Its industries include mixed farming, light engineering, and the manufacture of pharmaceuticals and bricks. Many Horsham people travel to London to work. See also **Sussex.**

Horticulture is a branch of agriculture that specializes in fruits, vegetables, flowers, and ornamental shrubs and trees. Horticulture includes the production, distribution, and processing of fruits and vegetables for food. It also involves the use of plants in landscaping and in such decorations as corsages and floral arrangements.

The word *horticulture* comes from the Latin word *hortus,* which means *garden,* and horticulture includes the art and science of gardening. Most horticultural crops were originally grown in gardens. Today, they are raised commercially on farms and in greenhouses, nurseries, and orchards.

Horticulture is widely practised as an industry and as a hobby. The horticulture industry is the main source of fruits and vegetables, and an important supplier of plants raised for their beauty. Horticulturists in the floral, landscaping, and nursery industries raise plants for use in creating attractive surroundings. Horticultural hobbies include flower arranging and gardening.

Much horticultural research is conducted at experimental stations, arboretums, botanical gardens, and colleges and universities. Some research involves developing methods to improve the cultivation of plants. For example, horticultural scientists experiment to determine the environment and nutrition necessary for good plant growth. They also work to develop ways to control plant diseases and pests. Other research involves breeding plants to produce new varieties that are especially beautiful, hardy, or productive.

Related articles in *World Book* include:

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Botany
Burbank, Luther
Espalier
Floriculture
Flower
Fruit
Gardening
Greenhouse
Herb
Hotbed
Landscape architecture
Market gardening
Nursery
Nut
Plant
Tree
Vegetable

Horton is a New Zealand family that became prominent in newspaper publishing. **Alfred George Horton** (1842-1903) bought a partnership in *The New Zealand Herald* in 1876. He helped to establish it as New Zealand's largest newspaper. He was born in Hull, Yorkshire, England, and settled in New Zealand in 1861. His son, **Sir Henry Horton** (1870-1943), succeeded him as director of the newspaper. **Ronald Duncan Horton** (1908-1961), the son of Sir Henry, also became a director of the newspaper.

Horus is the name for both the son of the Egyptian goddess Isis and of a number of ancient Egyptian sky gods. Horus the son of Isis was portrayed as a royal child, and the sky gods named Horus were shown as either falcons or falcon-headed men. The two types of Horus gods tended to be merged into a royal mythology surrounding the Egyptian pharaohs. These myths identified the pharaoh as both the earthly form of the royal falcon god who triumphs over his enemies and the pious son who claims the throne after the death of Osiris, his father. For an illustration of the sky god Horus, and a description of the role Horus the son of Isis played in the Osiris myth, see **Mythology** (Egyptian mythology).

The falcon god was worshipped under different names in various Egyptian communities, and distinctive myths developed around each of them. The eyes of Haroeris, also called the *great* or *elder Horus,* were the sun and moon. The Horus of Edfu, or *Behdety,* crossed the heavens each day as a winged sun disc. Harakhte, also known as *Horus of the two horizons,* was another sun god. The Egyptians later merged him with the sun god Re as the god Re-Harakhte.

See also **Isis; Osiris.**

Hosea, Book of, is a book of the Old Testament, or Hebrew Bible, named after an Israelite prophet. It deals with the prophet Hosea's ministry in the northern kingdom of Israel from about 745 to the 730's or 720's B.C., a period of great turmoil and uncertainty. The prophet witnessed the repeated killings and successions of kings. Many people worshipped pagan gods. Hosea regarded such worship as unfaithfulness to God and warned that evil would result.

Many scholars divide the Book of Hosea into two parts. The first describes Hosea's marriage as a symbol of God's relation with Israel. The second part tells the details and consequences of Israel's unfaithfulness to God, and promises God's love and blessings if it repents. Although Hosea shares many themes and ideas with other prophets, his use of symbolic names and the theme of marriage is unusual. His prophecy is also remarkable for its description of God as a loving father.

Hosiery. See **Stockings.**

Hospice is a kind of nursing home that specializes in the care of people who are dying. It aims to allow them to have the best possible quality of life and to die with dignity. The work of a hospice is based on three principles: good control of pain and other distressing symptoms; a close relationship between the patient and staff; and support for the patient's entire family.

Hospice staff use the most modern medical techniques in caring for and treating patients. They apply their special skills to looking after patients with cancer or AIDS, the elderly sick, and people with severe disabilities.

Hospice workers include not only doctors and nurses but also chaplains, occupational therapists, physiotherapists, psychologists, and social workers. All these workers are dedicated to the care of the patient. Bereavement counsellors help to give advice and support to families after a patient's death.

The hospice movement began in the United Kingdom. There are now more than 70 hospices in the UK alone and many more in other countries. The leading hospice is St. Christopher's Hospice, in southeast London. St Christopher's, the first modern hospice to be set up, carries out and coordinates advanced research and teaching in caring techniques, such as symptom control and patient and staff support.

More than 20 countries now apply the hospice philosophy. Japan and Singapore, for example, provide a few centres for care of the terminally ill that are run along hospice lines. India's first hospice, Shanti Avedna Ashram ("Peace in the absence of pain"), was established in Bombay in 1986. Its facilities include accommodation for family members.

Some countries that have adopted hospicelike care do not have special purpose-built hospice units. In parts of Australia, small hospitals run by general practitioners form a link between hospital services and home care for the terminally ill. In other countries, people who are dying are nursed at home. They and their carers receive full support, either at home or at day centres or inpatient facilities. In the Netherlands and Sweden, the authorities are seeking to develop services for the dying within existing institutions. Nursing and medical students also learn about the needs and care of dying patients and their families.

History. In medieval times, poor, homeless, and sick people took refuge in places called hospices. These were the forerunners of modern hospitals. Religious orders set up and ran many hospices, where those in extreme poverty could spend their last days. This practice continues today.

The modern hospice movement began in the mid-1900's, through the work of a British doctor, Dame Cecily Saunders. In 1947, she met a patient who was dying of cancer, and this encounter led her to the belief that dying is a part of life and that everyone is entitled to die with dignity and free from pain. A dying person is also entitled to be treated as an individual. In the 1950's, Dame Cecily worked at St. Joseph's Hospice, London, a centre for the terminally ill run by nuns. She opened St. Christopher's Hospice in 1967 and set the pattern for the modern hospice movement.

Hospital is an institution that provides medical services for a community. The doctors, nurses, and other personnel of a hospital work to restore health to sick and injured people. They also try to prevent disease and maintain health throughout the community. In addition, a hospital serves as a centre for medical education and research.

Millions of people must, at some point in their lives, spend some time in hospital as *inpatients.* Millions of others will visit hospitals as *outpatients.* Outpatients receive treatment but do not stay in the hospital.

To people living in most countries of the industrial world, a hospital is a clean building or complex equipped with modern medical facilities where doctors and nurses use up-to-date techniques to treat patients. But in a few developing countries, hospitals may be little more than crude huts or tents, where doctors and nurses work with limited drug supplies and medical equipment. Even in the developing world, however, hospital provision is expanding where financial resources allow. Each year, more hospitals are built to meet the needs of a rising population. Experts usually measure the level of hospital provision in a country in terms of the number of hospital beds it has available for patients.

Types of hospital

Hospitals vary quite widely in both the size of the institution and the kind of services provided. In most countries, hospitals form a vital part of an organized public health service.

At the lowest level of this service come hospitals that are small rural institutions serving a tiny local community. In the United Kingdom, such hospitals are often called *cottage hospitals.* These hospitals usually have less than 100 beds and offer general medical assistance with some limited specialist facilities.

District or *community general hospitals* form the next level of hospital provision in most countries. These hospitals serve larger population centres, such as towns and the suburbs of major cities. Besides general medical provision, these hospitals provide a wide range of specialist facilities. In the past, general hospitals consisted of up to 2,000 beds. But in the late 1980's and early 1990's, some countries replaced these with smaller (300-500 bed) hospitals that co-ordinate their services with those of the community. These more modern hospitals work more efficiently because they are less expensive to run and easier to administer.

In many developed countries, the top level of hospital provision is supplied by *specialist hospitals* or *teaching hospitals*. These are hospitals associated with medical schools, providing practical training for medical students. Teaching hospitals offer the most highly specialized services, such as brain surgery or heart and chest surgery, and also support facilities for medical research. Local family doctors or doctors in district general hospitals refer patients to a teaching hospital for *diagnosis* (determining the nature of a disease) and special treatment, which may include an operation and specialized nursing care.

Within the usual hospital structure of most developed countries are special hospitals or units within general hospitals that cater for specific types of patient. A *paediatric hospital* or *paediatric unit* deals solely with children. A *geriatric* hospital or unit accommodates old people. Eye hospitals care for patients with sight difficulties. *Acute hospitals* and *trauma units* provide emergency treatment and care for badly injured or seriously ill patients. *Maternity units* help protect mothers and new-born babies from infection by keeping them apart from other patients. A *premature baby unit* gives specialized care to babies born too early.

In addition to special units, general hospitals consist of several basic units. Chief among these are the *surgical unit* for patients requiring surgery, and the *medical unit*, for patients who require treatment by drugs. Surgery makes many demands on hospital resources. *Operating theatres* may be isolated from the rest of the hospital to reduce the risk of infection. The theatre is maintained in as *aseptic* (germ-free) a state as possible.

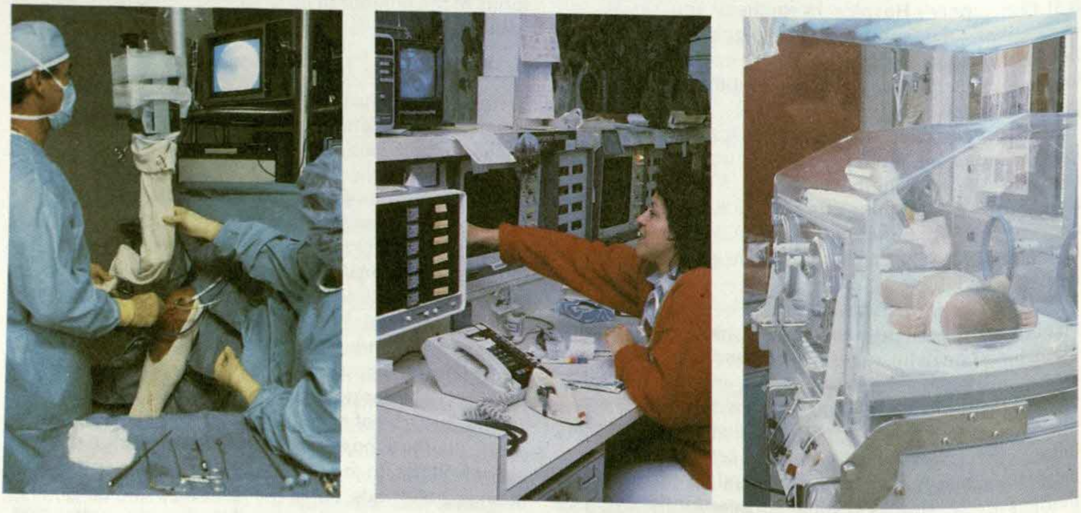
An *intensive care unit* provides round-the-clock nursing and monitoring for patients who are seriously ill. An *accident and emergency unit* or *casualty unit* treats accident victims and people who suddenly fall ill. Casualty units also provide ordinary outpatient services.

Hospital care

People go into hospital when they need medical care that cannot be given to them in their local doctor's *surgery* (office), or at home. People who have had an accident or suddenly become ill are taken to hospital straight away. But in ordinary circumstances people go into hospital after their doctor has referred them to a specialist there. In a hospital that forms part of a country's national health system, a patient may have to wait some time before being admitted. Private hospitals usually can admit fee-paying patients at a time of the patient's own choosing.

Hospital specialists usually see patients first at an outpatient clinic at the general hospital. There the specialists can use various facilities, including X rays and laboratory tests, to find out what is wrong with the patient. Once the specialist has made a diagnosis, he or she can decide whether the patient may continue to be treated in the outpatient's clinic, be placed under the care of his or her family doctor, or be admitted to hospital as an inpatient. A crucial factor in this decision is whether there are enough vacant hospital beds available to allow the patient to be admitted.

Once admitted, the patient is taken to a bedroom called a *ward* where he or she will stay while receiving treatment. Public wards are dormitories with several beds. In some hospitals there may be a lounge area attached to the ward where patients who need not stay in bed can relax, watch television, or read newspapers. Patients may also listen to the radio, and some hospitals even operate their own closed-circuit radio networks. Private wards are single, hotel-style bedrooms or suites. Patients may make telephone calls, and receive visits from friends and relatives. Paediatric hospitals or units have facilities for allowing mothers to stay in hospital with their children. The mothers can then help to nurse their children while they are receiving medical treatment.



Special equipment helps hospitals care for patients. In an operating room, *left,* surgeons use laser beams to perform complicated procedures. Electronic equipment, *centre,* lets nurses monitor patients' bodily functions. Incubators, *right,* help premature or sick babies survive.

Most hospitals are *short-term* or *short-stay* institutions in which the majority of patients stay for less than a month. Patients stay for an average period of 6 to 10 days in a short-stay hospital. In a *long-term* or *long-stay* hospital, patients stay for a month or more. Patients having their tonsils removed would go to a short-stay hospital. Psychiatric patients or patients suffering from a disease such as tuberculosis might attend a long-stay hospital. Psychiatric hospitals, geriatric hospitals, and *rehabilitation* hospitals, where people with disabilities receive specialized treatment to help them cope with the tasks of daily life, are all typically long-stay institutions. A general hospital may have long-stay units as well as short-stay units.

Hospital departments and personnel

The professional services staff consists of the people directly concerned with the care of patients. The *medical staff,* made up of doctors, directs all other members of this team. Most doctors have a general practice and send their patients to the hospital when necessary. They then supervise the hospital treatment.

In many hospitals, some doctors work directly for the institution and do not have a general practice. These doctors include such specialists as the *radiologist,* who directs a hospital's X-ray services, and the *anaesthetist,* who supervises the use of drugs for the relief of pain during surgery. In some hospitals, many or all members of the medical staff work directly for the hospital.

The medical staff also includes doctors in training. These *junior doctors* have graduated from medical school and work in a hospital for additional required experience.

The *nursing staff* forms the largest group on the patient care team. Professional nurses are those who have graduated from a school or college of nursing. They carry out much of the patients' care under the direction of doctors. Nurses also direct other members of the nursing staff, including *nursing auxiliaries.* These men and women do many routine necessary tasks and free the nurses for work requiring their special skills.

Professional services departments work with the doctors and nurses. A hospital *pharmacy* provides medicines which doctors have ordered for patients. A *central service* department maintains stocks of other medical supplies. A *food service* department prepares meals for patients and staff members. A dietitian directs this department and plans the menus. The dietitian also develops special diets for patients with certain illnesses when ordered by a doctor.

The hospital *laboratories* conduct tests that help doctors diagnose and treat illnesses. The *radiology* department makes X rays to help doctors diagnose diseases and injuries. Doctors also use X rays and other types of radiation to treat cancer.

Many hospitals have a *rehabilitation* department that works with disabled patients to help them return to normal life. There are two basic types of rehabilitation therapy, *physiotherapy* and *occupational therapy.* Physiotherapy treats diseases or injuries. Occupational therapy helps overcome or reduce physical handicaps by teaching the patient various skills. See **Occupational therapy; Physiotherapy.**

The *medical records* department keeps a record on every patient. If a former patient returns to the hospital, the medical record helps the hospital doctor to diagnose and treat the patient's illness.

Administrative departments. Most hospitals have an administrator who is responsible for the operation of the entire institution. The hospital's board of management or, in certain private hospitals, the owner, appoints this official. In some cases, a private management firm provides the overall administration of the hospital.

Various departments handle a hospital's business affairs. An *admissions office* schedules patients for admission at the request of their doctor and assigns them to a ward. An accounts department or *business office* lists the costs of treatment, and where appropriate prepares

A hospital provides many services to patients. In the emergency unit, *left,* accident victims receive immediate care. A radiologist, *centre,* studies *radiographs* (X-ray pictures) to help diagnose illness. At mealtimes, hospital workers bring trays of food to patients, *right.*

a patient's bill. A *purchasing department* manages a hospital's stockroom and buys supplies and equipment.

A hospital maintains a *personnel department* to hire employees and handle employee relations. A large institution may have a *public relations office* to inform employees, patients, and the public about the hospital's operation. Some hospitals employ *patient representatives* to deal with patients' complaints.

In some hospitals, a *volunteer services department, hospital friends group,* or similar organization, provides volunteer workers. These unpaid workers operate the coffee and gift shops in hospitals. They also run libraries and help to raise funds for the institution.

Other employees also help a hospital run smoothly around the clock. Cooks prepare nutritious meals in the hospital kitchen. Cleaners keep the institution clean to help prevent the spread of infection. Workers in the laundry department clean, sort, press, and mark the huge quantity of towels, sheets, and other linen used daily. Such experts as carpenters, electricians, engineers, plumbers, and air-conditioning technicians make repairs and adjustments to keep a hospital's machinery in top condition at all times. Hospitals also employ security personnel to protect patients and property.

History

Early hospitals. The word *hospital* comes from the Latin word *hospitalis,* which means a *house* or *institution for guests.* As early as the 200's B.C., Buddhists had set up hospitals in India. Early in the Christian Era, hospitals were established for sick or weary travellers, and for the poor, the blind, and the crippled. Religious orders operated most of these early hospitals. For hundreds of years, hospitals served chiefly as institutions to care for people who were too poor or too sick to be treated at home. Doctors did not work in the hospitals. They treated most patients in the patients' homes or in their own consulting rooms.

The oldest hospital still in existence is the Hôtel Dieu in Paris, founded during the A.D. 600's. Medical hospitals were founded in the wealthy city-states of Italy—Florence, Genoa, Venice, and Milan—in the 1300's. The hospital of Florence became renowned for its care of the acutely ill. Trained nurses looked after the patients, and junior doctors helped administer treatments prescribed by some of the leading doctors of the day. There were also women doctors and surgeons to attend to the female patients.

Although these institutions were admired, almost all European doctors limited their practice to rich and privileged people living in large cities. Medical students read ancient Greek, Latin, Arabic, and Jewish medical texts, but they did not study live patients. The first operating theatre, built in Padua in Italy in 1594, was designed for the then new science of human anatomy, and doctors gathered to learn and to exchange new ideas rather than to treat the sick.

In London, King Henry VII (reigned 1485-1509) founded the Savoy Hospital. It was almost the only medical hospital in Britain, and it was based on the Italian model. Henry VIII (reigned 1509-1547) copied the example set by the cities of Lyons and Geneva in establishing his great royal hospitals for the relief of the poor and sick (St. Thomas's and St. Bartholomew's), for vagrants (Bridewell), for poor orphans (Christ's), and for the distraught and insane (St. Mary of Bethlehem, which became known as Bedlam).

The Spanish government of Hispaniola built the first hospital in the Western Hemisphere in 1503. In Mexico City, Hernando Cortés founded a hospital in 1524. The first North American hospitals came into formal existence at Quebec, Canada, in 1639 and Philadelphia, Pennsylvania, U.S.A., in 1751.

In the early 1700's, European cities and towns began to build hospitals. These hospitals served mainly the poor or the victims of contagious diseases. They operated as charity hospitals. The wealthy did not go to hospitals. They usually received medical care at home. In Britain, however, the number of voluntary hospitals rose from none to 38 between the years 1735 and 1800. But, as doctors became interested in treating people in hospital, they concentrated on people with treatable illnesses such as scurvy, fractures, ulcers, and so on. People with long term or incurable illnesses were denied admission.

Early hospitals were crowded, dirty, and dark. The first hospital set up in Australia, for example, at Dawes Point, New South Wales, in 1788, consisted of wooden huts. The patients were laid out on benches. In all hospitals, the principles of sanitation were unknown. Diseases spread rapidly throughout hospitals because of lack of knowledge about the importance of cleanliness.

The 1800's. Medical discoveries in the 1800's helped begin the improvement of hospitals. In the 1840's, ether and chloroform were first used as anaesthetics to reduce the pain and shock of operations. In 1842, Crawford W. Long, from Georgia, in the United States, became the first doctor to use ether as an anaesthetic. Four years later, William T. G. Morton, a U.S. dentist, arranged the first hospital operation using ether as an anaesthetic. This operation was performed at the Massachusetts General Hospital in Boston. In Britain, Sir James Simpson of Scotland was the first to demonstrate the use of chloroform in childbirth.

During the late 1800's, doctors began to observe the principle of *antisepsis* (cleanliness to reduce infections). In 1865, Sir Joseph Lister began to use a spray of carbolic acid to kill germs in the air, and later insisted that surgeons use antiseptics to kill germs on their hands and instruments. This principle made surgery much safer. It started the continuing trend of caring for patients in hospitals instead of at home. Doctors could not establish the necessary cleanliness at home. The use of X-ray equipment in hospitals began in the late 1890's.

Another feature of the late 1800's was the growth of hospital schools of nursing. Florence Nightingale, through the nursing school she founded at St. Thomas's Hospital in London, revolutionized nursing around the world.

Also in the 1800's, hospitals began to establish rooms for private patients. The idea of the charity hospital started to diminish. Patients began to pay for part of the cost of their hospitalization.

The 1900's. Many hospitals were built in the United States during the early 1900's. As the number of patients increased, the cost of hospital care rose because of the need for more equipment and personnel. Many people could not afford the cost of hospital care, especially during the Great Depression of the 1930's. Hospitals often faced financial problems. In the United States the Blue Cross plan, developed in 1929, offered a form of prepayment insurance to help patients pay their hospital bills. Insurance helped put hospitals on a sounder financial basis as they could be sure of immediate payment.

In Britain, the National Health Service (NHS) came into existence after World War II (1939-1945). Under it hospitals were brought into a system of planned health provisions that had effect throughout the nation. The NHS is funded by the government. All taxpayers contribute to its support through National Insurance payments. Private medicine has continued to exist as an alternative for those who can afford it. In Britain during the 1980's and 1990's, government restructuring of the NHS was accompanied by measures seeking to encourage people to take out private medical insurance.

Recent developments. During the 1960's, hospitals became increasingly interested in serving the community. Many institutions set up outpatient clinics that offered general family or paediatric care. A number of hospitals began to provide laboratory tests, X rays, and various kinds of therapy for outpatients.

Many scientific advances helped improve patient care. For example, surgical and intensive care units now use electronic equipment to keep a continuous record of a patient's blood pressure, heart rate, respiration, and temperature. Computers help hospitals keep laboratory, medical, and pharmacy records. In addition, hospitals use many disposable items for convenience and safety. Such items include plastic thermometers and hypodermic syringes and steel needles. They are used only once, so they cannot spread infection. In the 1970's and 1980's, hospital technology made great advances with the introduction of ultrasound, magnetic resonance imaging, and computerized tomography scanners for analysing patients.

In the realm of patient care, the development of the hospice movement has completely changed the treatment of the incurably ill and the dying.

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Host, in biology. See **Parasite.**

Hostage is a person held prisoner to force fulfilment of an agreement or demand. If the agreement or demand is not met, the hostage may be killed.

Most hostages are taken in connection with crimes or political struggles. A bank robber or other criminal may seize hostages and threaten to kill them unless the police allow him or her to escape. Aeroplane hijackers may hold a plane's passengers and crew as hostages to obtain a ransom payment or transportation to a safe destination. Some kidnappers also hold their victims to ransom. Terrorists often take hostages to demand a certain action by a government.

In 1983, a United Nations treaty that outlaws the taking of hostages took effect. The treaty calls for the nations that have ratified it either to prosecute hostage takers or to send them back to their countries for trial.

Invading armies take hostages to discourage resistance. During World War II (1939-1945), Germany punished underground resistance forces by killing hostages taken in France, Poland, and other occupied countries.

During ancient and medieval times, nations often exchanged hostages to guarantee the terms of a treaty. The hostages, who were nobles or other important people, were treated as honoured guests. But they could be executed if the treaty was broken.

See also **Hijacking; Kidnapping; Terrorism.**

Hostel. See **Youth hostel.**

Hot dog. See **Sausage.**

Hot line is a two-way telegraph-teleprinter system that links Washington, D.C., and Moscow. The hotline is officially known as the Direct Communications Link. It allows the president of the United States and the president of Russia to communicate directly and instantly when an international crisis arises. Its purpose is to reduce the risk of war caused by misunderstanding.

The hot line was set up between the United States and the Soviet Union in 1963. It was first used when fighting broke out between Israel and Arab nations in 1967. In 1986, the hot line was expanded to include the ability to transmit graphic material. In 1991, after the Soviet Union broke up into a number of independent states, the president of Russia took the place of the Soviet leader at the eastern end of the hot line.

Hot rod is usually an older saloon car with an improved engine or body design. Hot rodders build their cars for either racing or normal driving. They seek to achieve the latest technology in brakes, steering, engines, and other parts to make the car run perfectly.

In Europe a hot rod usually means a car which has been highly *tuned* (adjusted for best performance) to race in small (400 metres or less) oval tracks in a non contact competition. This sport started in England in the early 1960's, and also developed in Germany, Holland, Belgium, and South Africa. It was based on stock car racing in the U.S.A. (see **Car racing** [Stock car racing]).

Hot springs are springs that discharge water heated by natural processes within the earth. Most hot springs are steadily flowing streams or calm pools of water. But many are *fumaroles, geysers,* or bubbling pools of mud called *mudpots* or *mud volcanoes* (see **Fumarole; Geyser**). Hot springs are also called *thermal springs.*

Hot springs originate when *surface water,* which results from rain and snow, seeps into the ground. Many springs occur in volcanic regions where hot molten rock called *magma* lies near the surface of the earth. Surface water trickles down through layers of rock until it is heated by the magma. Then the water rises to the surface through channels in the rock.

Hot springs also occur in regions that have *faults* (breaks) or *folds* (bends) in the layers of rock beneath the earth's surface. The temperature of the interior of the earth increases with depth. Faults and folds enable surface water to penetrate to depths where it is heated.

Many people believe that certain minerals found in some hot springs can relieve various ailments. Since ancient times, this belief has led people to bathe in the springs and to drink the water. Famous resort communities centre around the hot springs in such places as Hot Springs National Park in Arkansas, U.S.A., and Aachen, Baden-Baden, and Wiesbaden in Germany.

Hot springs are a source of *geothermal energy,* which is energy produced by underground steam or hot water. Several countries, including New Zealand and the United States, have power plants that use geothermal energy to generate electricity.

See also **Baden-Baden; Mineral water; Wiesbaden; Yellowstone National Park.**

Hotbed is a low, heated enclosure in which plants are grown during cold weather. Gardeners use hotbeds in spring to sprout seeds before the growing season. Hotbeds also protect plants from cold in autumn and winter.

A hotbed consists of a four-sided wood or concrete frame built on the ground and covered by glass to allow the maximum amount of sunlight to enter and help warm the growing area. The frame is heated either by electric heating cables located under the soil and controlled by thermostats or by a boiler that sends steam, hot water, or hot air through pipes.

Gardeners once heated hotbeds by burying a thick layer of manure under the soil. As the manure decayed, it produced heat and fertilized the soil. A structure similar to a hotbed but heated only by sunlight is called a *cold frame* (see **Cold frame**).

See also **Greenhouse.**

Hotel is an establishment that provides overnight accommodation for the public. Its basic service is providing a room to sleep in. But most hotels also have at least one restaurant. Many large hotels offer rooms and services for meetings, and some have shops and offer entertainment.

Hotels range in size from large buildings with more than 3,000 rooms to small inns that have fewer than 10 rooms. Small hotels do not offer the range of services provided by the large establishments. However, rooms and meals at most small inns cost less than those at large hotels. Many small hotels are owned and operated by members of one family.

Many modern hotels employ about one staff member for every two rooms. The hotel staff works around the clock to make the guests comfortable. The housekeeping staff cleans each room daily. Porters carry luggage and packages to the guests' rooms. The maintenance department keeps the hotel's electricity, plumbing, heat, and air conditioning in good working order. The hotel security department works to prevent fire, theft, and other disturbances.

Most hotel restaurants provide *room service,* by which guests can have food and beverages brought to their rooms. Guests also can have clothing laundered by the hotel's *valet service.* Some hotels charge guests for a room only. Meals and other services cost extra. Many hotels offer room and *board* (either breakfast only, or breakfast and dinner) for a fixed charge.

Kinds of hotels. There are three chief kinds of hotels: (1) commercial hotels, (2) resort hotels, and (3) residential hotels.

Commercial hotels. Most commercial hotels are near the airport or the centre of large or medium-sized cities. These hotels serve mainly business travellers and other people on short trips. Many provide luxurious surroundings and a wide range of services.

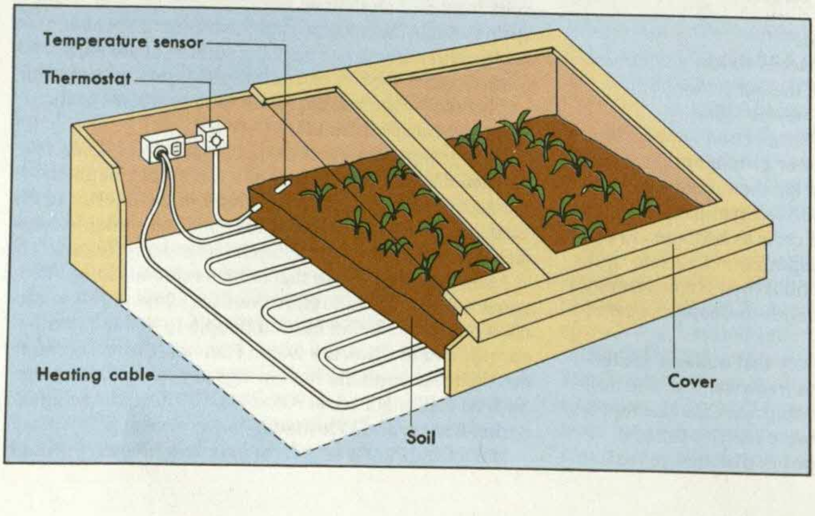
The guests in most commercial hotels have a choice of several restaurants, ranging from inexpensive coffee shops to elegant dining rooms. Some of these hotel restaurants offer music, dancing, and other entertainment. Shops in commercial hotels include clothing stores, gift shops, and news stands. Some commercial hotels have hairdressers and beauty salons, and many have swimming pools and saunas.

Many commercial hotels have large rooms that their guests and other groups can use for banquets, conventions, and meetings. The hotel's catering department provides meals and snacks for such events.

Resort hotels provide holiday accommodation for tourists and holiday-makers. Some hotels feature golf, skiing, swimming, and other outdoor activities. The guests stay for periods ranging from a weekend to several weeks. Most resort hotels are near lakes, mountains, or the sea. But some stand within easy reach of large cities and serve as holiday spots for nearby residents.

Business is seasonal at most resort hotels. During the cold months, for example, large numbers of people travel to mountain resorts to ski.

Resort hotels also provide indoor activities for their guests. Many have gymnasiums, games rooms, and indoor swimming pools and tennis courts. Some feature dancing, music, and other forms of entertainment.



A hotbed protects plants grown during cold weather. The electric hotbed shown at the left has heating cables buried in the soil and a thermostat that controls the temperature. The slanted, transparent cover lets in sunlight and also helps keep the enclosure warm.

Resort hotels are often located near the sea. Holiday makers at this resort hotel on the island of Maui, Hawaii, enjoy swimming, surfing, and other outdoor activities.

Residential hotels rent one or more rooms to guests for long periods of time. These hotels resemble apartment buildings but also offer meals and maid and valet service.

History. The earliest inns were established about 3000 B.C. Most of them were private homes whose owners provided rooms for travellers. Many early innkeepers did not keep the rooms clean, and they provided only crude meals for their guests. Several travellers usually had to share the same room and sometimes even the same bed.

In India, a traveller in the countryside could stay for a fixed price at a *dak* (resthouse). Daks were first set up by the emperor Asoka (272-232 B.C.). In the 1600's many inns in Britain and in other European countries were built beside roads used by stagecoaches. Passengers rested and took refreshment at the inn, and the innkeeper also sold tickets for the coaches.

The quality of inns, especially of those in Europe, improved during the 1700's, as more people began to travel for pleasure. The invention of railways in the 1800's led to the building of larger railway hotels, close to stations in major cities. Railways made it possible for more people to travel and to take holidays. This encouraged the development of resort hotels and of smaller hotels or guesthouses beside the sea and in the lakes and mountains.

In the late 1800's cities such as London and Paris became noted for large, luxury hotels catering for wealthy guests, London's Savoy Hotel, for example, opened in 1889, and had electric lighting in every room. Splendid restaurants became a feature of such hotels. Hotels now offered lifts, private bathrooms, and other facilities to attract guests. Modern hotels often provide a telephone, radio, and television in every room.

During the mid-1900's, numerous hotels owned by one person or company were built in cities, particularly in the United States. These hotels make up *hotel chains,* which can operate more efficiently and at less expense than most independent hotels. All hotels in a chain function the same way and use the same name. Some chains operate hotels in many countries.

The lobby of a commercial hotel, *above,* provides elegant surroundings where travellers can relax. Commercial hotels serve business travellers and other people on short visits.

A luxury hotel caters for wealthy guests. This hotel on Lake Pichola, Udaipur, Rajasthan, India was once a Rajput palace. It has courtyards, fountains, and gardens.

Some hotel chains use the *franchise system.* In this system, a person or company buys the right to own and operate a hotel in the chain. The owner also pays the chain part of the hotel's income in return for use of the chain's well-known name and reputation.

The growth of the modern hotel chain has reduced the number of privately run large hotels, but many smaller establishments remain. Hotels are graded, according to the facilities they provide.

See also **Hilton, Conrad; Motel; Youth hostel.**

Hotham, Sir Charles (1806-1855), was governor of Victoria, Australia, in 1854 and 1855. He was born in Suffolk, England, and arrived in the colony during disputes on the Victorian goldfields. He promised the miners the right to vote, but only if they paid for goldmining licences. At Ballarat, miners refused and burnt their licences. Hotham sent troops there, and they stormed the Eureka Stockade. In 1855, he appointed a commission to look into miners' grievances. See also **Eureka Stockade** and **Australia, History of** (Toward a nation: The Eureka Stockade).

Hottentot. See **Khoikhoin.**

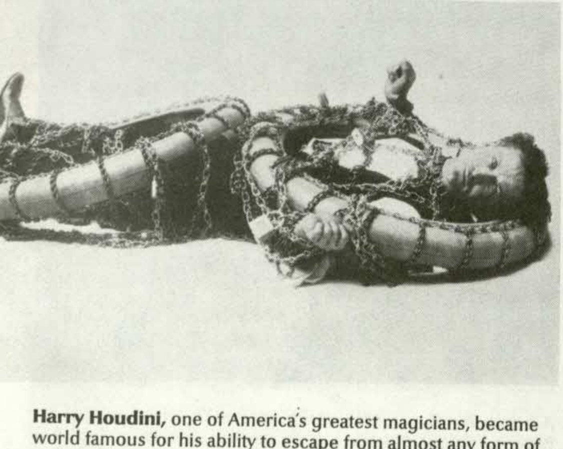
Houdini, Harry (1874-1926), was an American magician who won world fame as an escape artist. Houdini could quickly free himself from apparently escapeproof devices, including leg irons, 10 pairs of handcuffs, jail cells, and nailed crates. His most sensational feat consisted of escaping from an airtight tank that was filled with water.

Houdini performed many publicity stunts to stimulate interest in his act. For example, he let himself be tied in a straitjacket and hung upside down from the eaves of a tall building. He struggled free in a few minutes. Houdini also became known for criticizing spiritualist mediums, who claimed they could communicate with the spirits of the dead. He believed that mediums deceived the public, and he duplicated their feats in an effort to show they were frauds. Houdini was also the star of several films.

Houdini was born in Budapest, Hungary. His family moved to Appleton, Wisconsin, U.S.A., when he was a child, and Houdini later claimed he was born in Appleton. Houdini's real name was Ehrich Weiss. He took his stage name from Jean Eugène Robert-Houdin, a great French magician of the 1800's. He later made it his legal name.

Houdini began his career performing card tricks in a museum. By 1900, after developing his escape act, he became a star and performed in many leading theatres throughout the world. Houdini's show featured magic tricks, escapes, and demonstrations of what he regarded as spiritualist fraud.

See also **Magician** (picture).



Harry Houdini, one of America's greatest magicians, became world famous for his ability to escape from almost any form of restraint, from chains and handcuffs to federal prison cells.

Houdon, Jean Antoine (1741-1828), was probably the greatest French sculptor of the 1700's. Most critics now rate him as the leading European sculptor of his time.

Houdon was primarily a portrait sculptor, but he also occasionally worked on mythological and religious figures. He worked in plaster, clay, stone, and metal. He made many popular works in each of the four media. Houdon created works of classical grandeur and dignity, as well as works of a much more informal and intimate character. He could suggest endless variety and shades of meaning in the personalities of his subjects. Houdon also had a control in working his materials that has seldom been equalled in sculpture.

Houdon was the first major European artist to visit North America. He went in 1785 to model a portrait of George Washington. Houdon made several portraits of Washington, including the full-length statue that stands in Richmond, Virginia. He also made portrait busts of Thomas Jefferson, Benjamin Franklin, John Paul Jones, and Robert Fulton. These portraits are among the most impressive artistic documents left from the early years of the American republic.

Houdon was born in Versailles. From 1764 to 1768 he studied at the French Academy in Rome. He returned to Paris in 1768 and settled down to a long, productive career lasting until 1814.

Hound is the name of a group of dogs. Hounds are of two types: those that hunt by following the scent of their quarry, and those that hunt by sight. Scent hounds include the foxhound, beagle, bloodhound, basset hound, and dachshund. Sight hounds are also known as gazehounds. Among sight hounds are the greyhound, Afghan, borzoi, deerhound, Saluki, and Irish wolfhound. The typical hound has long ears, strong legs, and a long tail. Hounds are alert, love the outdoors, and have great endurance. They are among the oldest known dogs. For additional information on hounds, see **Dog** (Hounds; picture: Hounds; table).

Related articles in ***World Book*** include:

Afghan hound
Basenji
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English foxhound
Foxhound
Greyhound
Harrier
Ibizan hound
Irish wolfhound
Norwegian elkhound
Otter hound
Pharaoh hound
Rhodesian ridgeback
Saluki
Scottish deerhound
Whippet

Hounslow (pop. 194,100) is a borough within the Greater London area. It comprises the former areas of Brentford and Chiswick, Feltham, and Heston and Isleworth in west London. Historic buildings in the borough include Chiswick House and Syon House. Part of Heathrow Airport is in Hounslow. Feltham has some industrial development. Brentford and Chiswick are mainly residential areas.

Houphouët-Boigny, Félix (1905-1993), was president of Ivory Coast from 1960 when that nation gained independence from France until his death in 1993. As president, Houphouët-Boigny helped unite the country's many ethnic groups. He maintained close relations with France and other Western European nations. Ivory Coast receives much economic support from those nations. Under Houphouët-Boigny, Ivory Coast achieved political stability and much economic progress. However, economic problems helped cause some political instability in the early 1990's.

Houphouët-Boigny was born in Yamoussoukro, near Dimbokro, Ivory Coast. He practised medicine for many years before entering politics in the mid-1940's. He served in the French government from 1945 to 1959. He helped bring independence to Ivory Coast and other French-controlled African areas.

Hour is an interval of time. It consists of 60 minutes. A day, from midnight to midnight, has 24 hours. Every nation regulates its activities according to the hour. People started using hours as uniform periods of a day in the 1300's, when the mechanical clock was invented.

The ancient Romans used the hour to note a point of time, such as sunrise and sunset. They later added the hour of noon. At the beginning of the Christian era, the Romans divided the hours of daylight into five periods, which they marked on their sundials. In A.D. 605, the Christian church named the *seven canonical hours,* or hours of prayer. They were (1) *matins* (morning) and *lauds* (praise), (2) *prime* (first), (3) *tierce* (third), (4) *sext* (sixth), (5) *nones* (ninth), (6) *vespers* (evening), and (7) *complin* (complete). These hours marked only periods of daylight, beginning at 6 a.m. The nights were sometimes divided into *watches,* which marked the times when guards reported for duty or were changed. The length of the hour varied with the season. The winter hours were shorter than the summer hours, because there was less daylight during the winter.

By the 1500's, many churches and palaces in Europe had installed mechanical clocks with 12-hour dials. These clocks did not keep good time, and had to be set every sunny day at noon, when the sun was at its highest point, or *on the meridian.* From this we get the letters a.m., meaning *ante* (before) *meridiem,* or before noon in Latin. p.m. means *post* (after) *meridiem,* or after noon. When people first began to tell the time by the clock, they substituted the word *o'clock,* meaning by the clock, for the word *hour.*

Confusion can result if the letters a.m. and p.m. are not used. European railways and aeroplane timetables use a single 24-hour system. To avoid confusion, four figures are used. Thus, 1.00 a.m. is written 01.00. 1.00 p.m. is written as 13.00, and 12.00 midnight is 24.00. In conversation, all four figures are sometimes used, such as "O one hundred" for 1.00 a.m., "twelve hundred" for 12.00 noon, and "twenty-four hundred" for 12.00 midnight.

See also **Clock; Day; Time.**

Hour circle. See **Astronomy** (Locating objects in the sky).

The hourglass was used to measure time before clocks were invented.

Hourglass is a device that measures time. It has two glass bulbs joined together by a small opening. One of the bulbs contains grains of fine, dry sand. The sand takes exactly one hour to drain from the top bulb to the bottom bulb. When all the sand has run from the top bulb, the hourglass is turned over, and the sand begins to run into the empty bulb as before. Some earlier hourglasses contained mercury, but sand works better because it flows at an even rate, regardless of the amount the bulb contains. An hourglass that contains sand may be called a *sandglass.*

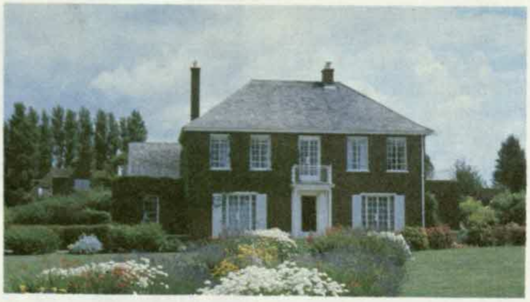
Smaller glasses, such as the *half-hour glass,* measure shorter periods of time. Even smaller glasses measure the time needed to boil eggs. These are called *egg timers.* For many years, hourglasses were used to limit the amount of time a speaker could talk. Until the 1900's, sailors used a device like an hourglass that measured less than a minute while the log line was allowed to run out. In this way, they could determine how fast the ship was travelling. Hourglasses were widely used before the invention of mechanical timepieces. However, they have been replaced by watches and clocks. Many writers have mentioned the hourglass to express the passage of time.

House, in astrology, is a division of a chart that supposedly reveals a person's character or future. The chart, called a *horoscope,* is divided into 12 houses. The houses represent 12 departments of a person's life: (1) appearance and personality, (2) possessions, (3) family relations, (4) parents, (5) children, (6) health, (7) friends and marriage, (8) death, (9) travel, (10) career, (11) ideals, and (12) illness and sorrow. The houses also are related to 12 imaginary divisions of the earth's surface. Astrologers supposedly tell fortunes by explaining the influence of the planets and stars on each house (see **Horoscope** [Parts of a horoscope]).

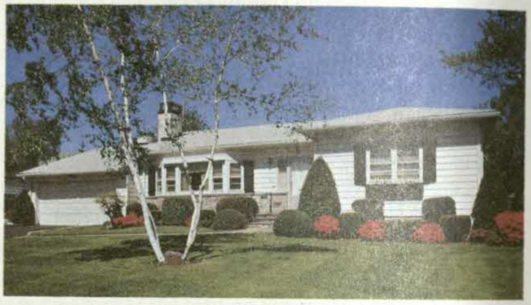
See also **Astrology; Zodiac.**

House is a building that provides shelter, comfort, and protection. Houses vary in size from one-roomed mud huts to many-roomed mansions. They may have only one *storey* (floor), or several storeys. They stand in cities, towns, and villages, and in both suburban areas and the country. Types of houses vary with the needs and wealth of the inhabitants, and with the building materials that are available. Many large buildings are divided into *flats,* or *apartments.* Each flat is a complete, self-contained home on one storey. Houses may also be divided into self-contained *maisonettes,* each occupying two or more storeys.

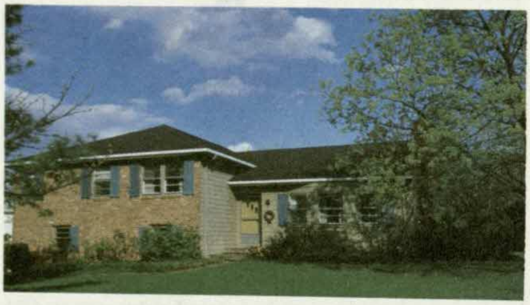
Styles of houses vary widely from country to country. And, in many countries, the style of new houses has changed with passing time. Many house styles are named after the country or period of their origin. Others are named after the architects who created them. European historical styles include Romanesque, Gothic,



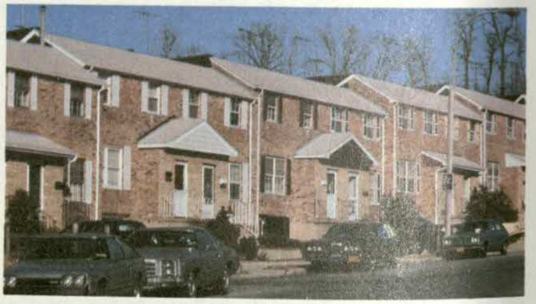
A Georgian house has a regular shape. The style developed in England during the 1700's and 1800's.



A ranch-style house has all its rooms on one level. Such houses are popular in Australia and the United States.



A split-level house has a level half a floor above the main level and, in some cases, another level half a floor below.



Terraced houses, or town houses, line the streets of many cities. Such houses share a wall with a neighbouring house.

Renaissance, Baroque, and Rococo. Architects who founded styles used for houses include the Italian Andrea Palladio and the Adam brothers of Britain. For a description of styles in architecture, see **Architecture.**

The factors that influence the size and design of houses include climate, social customs, building techniques and materials, fashion, and wealth. Religious beliefs also influence style. For example, houses in some countries of eastern Asia have roofs that curve upwards at the eaves. The people believe that these roofs protect them from evil spirits. Other house styles are a result of social conditions. For example, in Britain during the early 1800's, many wealthy people and the nobility commissioned the best architects to design their homes. They built fine, graceful houses suited to a leisurely life requiring large domestic staffs. But, today, most new houses are easy to maintain and comfortable for small families.

Local styles of houses are now less common than in earlier times. House styles have become more uniform in most parts of the world, because of new building materials and methods. A factory may produce prefabricated parts for houses to be erected quickly on site, instead of being built in stages.

Environment has an important effect on the houses that people build. In areas of great heat or cold, houses must be built to protect people from extreme temperatures. The traditional houses of the Eskimo people of the Arctic were built of blocks of snow. These snowhouses, called *igloos,* provided excellent insulation against the very low temperatures outside (see **Igloo**). In the extreme heat of the deserts of the Middle East, nomadic people called Bedouins lived in large tents made of fabric woven from the hair of their camels or goats. The thick material protected the people from the sun but could be opened at the sides so that air could circulate. Since the mid-1900's both of these traditional styles of house have been replaced by housing built of more modern materials.

In Japan, houses were traditionally made from light materials, such as paper and bamboo. These *paper houses* collapse harmlessly if there is a volcanic eruption or an earthquake. Then the people can quickly and cheaply rebuild them. The *stilt houses* of Southeast Asia are also well adapted to their environment. People build these houses on tall poles in areas where floods might wash away ordinary houses, or where insect pests might invade them.

In alpine regions, where much snow falls, houses have steeply sloping roofs. As a result, the snow falls off easily. Sloping roofs are also needed in places where heavy seasonal rains fall. But, in hot, dry countries many houses are box-like, with flat roofs. The houses remain cool in the intense heat because the shuttered windows are small and the thick walls are painted white to reflect the sunlight.

In towns and cities, land is expensive, and much housing must occupy a small area. As a result, builders may construct tall blocks of flats or long, continuous rows of *terraced houses.* But, in the country, more land is available, and *detached houses* and single-storey *bungalows* stand in their own large gardens or grounds. The suburbs of many British cities have *semi-detached houses,* each of which is linked to a similar house.

Materials used to build houses vary from mud and grass for tribal huts to factory-made one-room units for blocks of flats. Kinds of materials may be divided into two types: traditional, and modern.

Traditional materials include snow, mud, wood, bark, twigs, creepers, grass, leaves, dried blood, and stones. They may be used as they are found. Generally they are not strong materials. As a result, houses built from them must be small. But bamboo is strong and light, and it may be split and joined easily. Large jungle leaves give good protection from heavy rain. Mud seals cracks in walls and prevents draughts. A mixture of mud and animals' blood dries to make a solid floor.

Traditional materials also include wood, stone, timber, slate, tile, bricks, mortar, and plaster. They include natural and manufactured materials that are fashioned with tools. All heavily wooded countries have many timber houses. These houses are warm in cold weather, because wood is a good insulator. Stone houses are common in areas where stone can be quarried locally. But stone is a bad insulator and stone walls must be thick. Slate and factory-made tiles make strong, permanent roofs.

Wood has long been a popular building material because it is usually more plentiful and cheaper than other materials. Wood can be cut and shaped to provide a variety of house styles. Wood is also popular because so many different types are available. Wood is also used for such interior features as stairways, cabinets, floors, and doors. Wood can be natural, stained, painted, or carved. See **Timber.**

Brick is one of the oldest and most common building materials. Brick wears well and, like wood, is usually easy to obtain. Bricks are available in a number of colours and finishes. See **Brick.**

Concrete block and stone make strong, attractive houses. Concrete blocks are made by pouring a mixture of cement into a mould. They make durable houses that are relatively cheap to maintain. Builders also make houses of stone that has been taken from quarries and split into usable sizes. Because stone is an expensive building material, it is usually applied in a *veneer,* or coating, over an inner wall of brick or concrete block. See **Building stone; Cement and concrete.**

Modern materials in today's houses differ greatly from those of 100 or even 50 years ago. Industries have developed new materials that help architects design better, longer-lasting houses. For example, builders once used iron for gutters and pipes. The iron rusted. Today, builders can use plastic, which does not rust. Aluminium, which does not rust, and nonrotting plastic materials such as PVC can be used instead of wood or metal for window frames and doors.

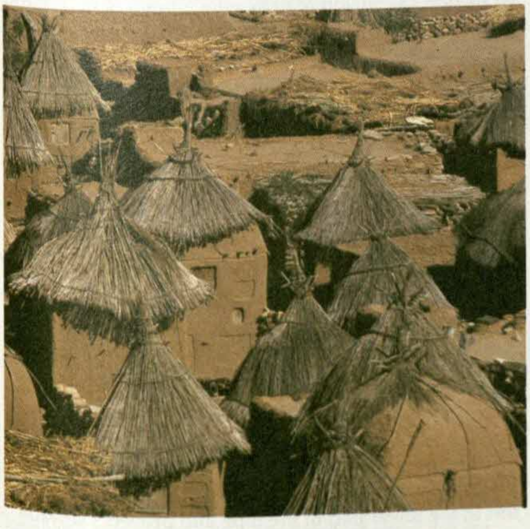
Older houses usually had small windows that let in only a small amount of light. Their window frames were loosely constructed and were not always airtight. Houses today have improved, airtight window frames to conserve heat.

Building a house

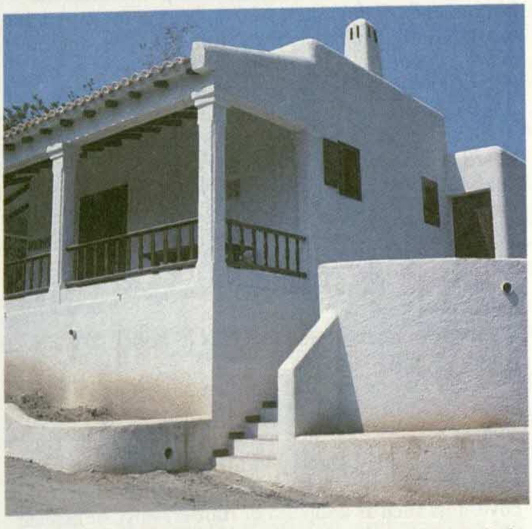
Planning the house. The way a house is built depends on the style of house and on the kind of materials chosen. In most countries, an architect works with the builder to propose plans on the new house. These plans must conform to local laws and electrical, building, and plumbing codes (see **Housing** [Local housing controls]).

The architect then designs the house according to the buyer's ideas. He or she makes specifications and blueprints. They provide information on size, materials, and how the house is to be built. The architect may also supervise the actual construction of the house.

The foundation supports the house. First, building workers begin *excavating,* or digging, holes or trenches for the *footings,* the lowest part of the foundation. The footings support each wall load. They are made by pouring concrete into wood or steel forms. Footings usually extend from 30 to 180 centimetres beneath ground level. Builders generally use concrete or concrete block for the house's foundation, which may extend from 20 to 90 centimetres above the ground.

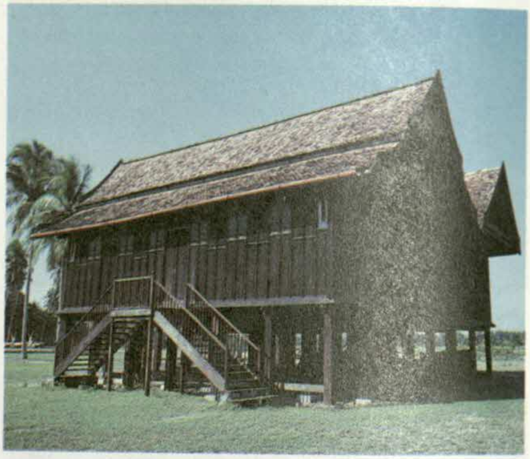


Mud houses, like these in Mali, provide good shelter from the heat in areas where there is little rainfall.



Houses in southern Europe, like this one in Spain, have thick stone walls painted white to reflect the sunlight.

Houses in Guadalcanal, in the Solomon Islands, are built of traditional materials which are all found in the forest.



A traditional timber house in Malaysia is raised on stilts to protect it from flooding.

The area within the foundation below the first storey is the *basement.* Basements add to the cost of building a house, but they provide extra room.

In many low or damp regions, houses are raised above the ground on concrete *piers,* or supports. Sometimes a *slab* foundation is laid directly on the ground, especially if the earth beneath the house is hard. The ground must first be *graded,* or levelled. Workers then spread a *filler,* usually stone, and cover it with a moistureproof paper. The filler and the paper prevent moisture from coming through the slab that is made by pouring concrete, about 10 centimetres thick, directly on top of the paper.

Outer walls may be made up of *courses* (layers) of bricks, or of a wooden frame. The frame supports vertical wooden walls.

The roof seals the top of the house. Some roofs are flat, but most are slanted. Slanted roofs are often formed by pieces of timber called *rafters.* Carpenters nail the bottom ends of the rafters to the plates at the top of the outside walls. The rafters slant from the plates and meet at the *ridgeboard,* a board placed at the *ridge,* or top edge, of the roof. Rafters support the weight of the roof. Joists support the weight of the floor.

After carpenters nail a *sheathing* (inner layer) of fibreboard or plasterboard to the tops of the rafters, they add heavy building paper or building felt to it. Then they add the final layer of slate, or tiles, or roofing asphalt. *Flashing,* or strips of sheet metal, placed around the chimney and other roof openings, insulates the roof from the chimney and also prevents water from leaking into the house. See **Roof.**

Interior construction includes (1) floors, (2) walls, (3) windows, and (4) doors.

Floors may be made of wooden boards or a wood covering. Most finished floors are made of hardwoods such as maple or oak that have been finely sanded and later sealed with a wood filler. The wood may then be finished with wax, shellac, or varnish. Other floors have coverings such as linoleum or rubber, vinyl, or asphalt tile. See **Flooring.**

Walls. Rooms are made by building inside walls after the outside walls have been attached to the foundation. Inside walls, are called *partitions.*

If plaster is to be applied, the interior walls must first be covered with *lath,* or strips of wood, metal, or plasterboard. The lath is set horizontally about 8 centimetres apart. Wallboard, plasterboard, or plywood may be used in place of plaster (see **Wallboard**).

Windows. Most parts of a window come from a factory or builder's merchant, already cut in the proper sizes. See **Window.**

Doors. Both doors and door frames may usually be bought ready-made. Carpenters attach the doors high enough to swing over rugs or carpets. A *threshold* fills in the space under an outside door.

Electrical wiring provides lighting and furnishes outlets for lamps, washing machines, and other appliances. In some houses, electricity also provides heat. Electricians install wiring. Wiring is done in a series of circuits. Each set of wires has several outlets. Electricians often place the wiring for central heating on a separate circuit. This keeps the system running if another circuit breaks down.

Wires become hot and can cause fires if they are overloaded, so electricians install a fuse for each electrical circuit (see **Fuse** [Electric]). A *fuse box* usually holds all the fuses. If too much current passes through a circuit, the wire in the fuse melts, or "blows." Electricians often install another protective device called a *circuit breaker,* instead of a fuse box (see **Circuit breaker**). If the circuit becomes overloaded, then the circuit breaker will automatically cut off the current (See **Electric circuit**).

Plumbing. During construction, plumbers install the pipes that will supply gas and water, and carry away waste. They install bathroom fixtures and sinks just before other workers add the finishing touches to the house. Plumbers also install *traps* to keep out sewage gas. The trap used for bathroom wash basins, for example, is a curved pipe directly below the drain. Water settles in the lower part of the pipe and prevents sewage gas from backing up and leaking into the room. To function properly, traps must have outside ventilation. The small pipe that projects from the roof of a house is a ventilating pipe for sewage gas.

A cast-iron waste-disposal pipe runs from inside the house to about 1.5 metres outside, where it connects with a pipe of another material, usually clay. This pipe connects the home-disposal pipe with the local sewerage system. In areas without a local sewerage system, a *septic tank* near the house holds sewage until it dissolves. Water from the sewage flows through pipes into the ground. The sludge remaining in the tank must be removed at intervals. See **Plumbing; Sewage.**

Insulation reduces the amount of heat or cold that passes through walls, floors, and ceilings. When the air around the house is warmer or colder than the air inside, heat passes from the warm air to the cold air. This means that in winter, the heat will pass to the outside, and the house will become cold. In summer, the heat outside passes into the house. Insulation fills the air spaces in walls, floors, and ceilings, and creates *dead-air space.* This helps prevent heat loss. Insulation can reduce fuel costs in heating a house. See **insulation.**

Heating and air conditioning may also be fitted. See **Air conditioning; Heating.**

Landscaping is the last step in building a house. Most builders try to keep the natural outline of the land and to preserve the trees. Of course, some levelling and some excavating of land must be done. After the house is finished, the builder may plant seed or lay rolls of grass turf for a lawn around the house. The builder may also plant trees and shrubs. See **Gardening; Landscape architecture.**

Many people prefer to build their own houses. But most new houses in developed countries are built by companies or local government authorities, who then offer the houses for sale or rent. For the various ways of financing housing projects, see **Housing.** For a description of the general principles of building see **Building Construction.**

Buying and renting houses.

Finding a house. In most countries, *estate agents,* or *brokers,* help people who wish to buy or sell houses by keeping lists of houses for sale. In some countries, *housing co-operatives* buy and sell houses. If a person wishes to buy a house in a particular area, an agent gives him details of suitable houses. The agent arranges for the buyer to visit the properties, and helps in the negotiations between the buyer and seller. The agent may also arrange an expert inspection of the property, and help to secure a mortgage loan. See **Mortgage.** The agent receives a *commission* (fee) from the seller when the house is sold.

Some sellers advertise their houses for sale in newspapers and other places. The buyer then negotiates the sale directly with the seller. No agent's fee need be paid, and, as a result, the price may be lower. In some countries there are no estate agents, and lawyers do not negotiate the sale. Instead, banks may help. Many development companies and building contractors also offer their houses for sale directly to buyers.

Inspecting the house. Buyers should inspect a house thoroughly. They should see whether the site is low-lying and liable to flooding, and whether it is exposed to strong winds. They should study the living accommodation to see that it is arranged in a convenient and labour-saving way. A buyer should also study the general condition of the house. A house in bad condition may have leaning, bulging, or cracked walls, a sagging roof ridge, or damp patches on the walls and ceilings.

Before deciding to buy the house, the buyer should have it inspected by a qualified surveyor. The surveyor will look for such defects as damp, rot, woodworm, subsidence, and defects in the walls, roof, and beams. The surveyor will check the plumbing, drainage, and electric and gas fittings. In his report, the surveyor will tell the buyer whether any money need be spent on repairs, and whether the price asked is fair.

Financing the purchase. If the buyer cannot afford to pay the whole of the purchase price of the house, he or she can generally borrow part or all of it. The person lending the money keeps the *title deeds* (documents of ownership) of the house until the loan is repaid. The borrower must generally repay the loan in instalments. If the borrower fails to repay the loan, the lender can sell the house to recover the money. This kind of loan is called a *mortgage loan.* Mortgage loans may be made by a bank, insurance company, local or national government authority, building society, or private person.

Renting. Many people rent houses and flats instead of buying them. A person may occupy a rented house on a tenancy or on a lease. A *leaseholder* has a legal contract with the *landlord* (owner) of the house. This lease states that the leaseholder may occupy the house for a certain period at a fixed rent. The period of the lease may be a few years, or as much as 100 years. The leaseholder buys the lease, and also pays the landlord an annual *ground rent.*

A *tenant* has no lease. Generally, a tenancy is for an indefinite period, and the tenant may leave at any time. The landlord may ask the tenant to leave, and he may ask for extra rent, which is generally paid weekly, monthly, or yearly. Many landlords let furnished houses and flats to tenants.

History

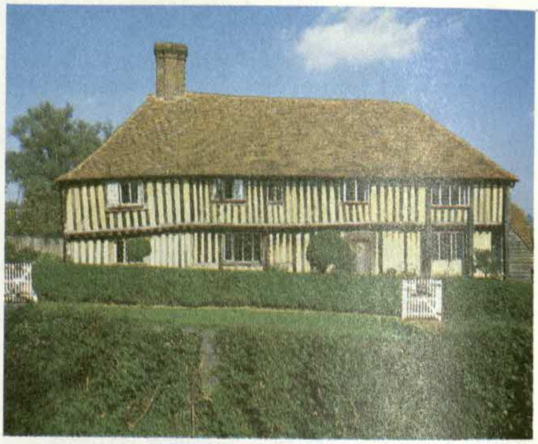
In early prehistoric times, people had no houses. They lived in the open air or in caves. But, as primitive people learned to use tools, they could build their own shelters. If mud and straw were available, they built mud huts with thatched roofs. If they lived near a forest, they built shelters from the branches of trees. In many countries, people lived in cliff dwellings built against the rock face, or in natural caves. In the river areas of Asia, people lived in houseboats on the water. People still live on boats, and, in some parts of the world, a few people still live in huts and shelters much like those of prehistoric people.

As early civilizations developed, people learnt to shape natural materials and to make new materials for building. About 5,000 years ago, during the Bronze Age in the ancient civilizations of Babylonia and Egypt, people built houses with stone and sundried brick. The people of ancient Greece, more than 2,000 years ago, also used stone and brick for house building. They covered walls with *stucco,* a kind of plaster. The people of ancient Rome built many spacious and luxurious villas and houses. These villas had brick walls, tiled roofs and baths, mosaic floors, lead plumbing, and under-floor heating. Some had glass windows. People in Arabia, India, China, and Japan developed advanced town-civilizations, with well laid out streets of houses. Some houses were multi-storey.

During the A.D. 400's and 500's in Europe, the Roman Empire declined, and people forgot the Roman methods of house building. In many countries, they built barnlike wooden houses supported by huge arched timbers. They built few stone houses. But, by the 1000's, people in Europe had built many large castles for protection against attack. The great hall of such a castle might hold many families. During the Middle Ages, life became more peaceful in Europe. Merchants became rich, and towns developed. Houses were built close together in narrow streets. They had frames of timber and walls made from *wattle and daub.* This was a base of *wattle* (interwoven sticks or twigs) over which was *daubed,* or spread, a mixture of clay, lime, water, and sometimes dung or chopped straw to make the wall airtight.

During the 1400's, architects in Europe developed the Renaissance style of architecture from the classical styles of ancient Greece and Rome. They built houses with wide staircases, formal *façades* (fronts), and spacious rooms. In the next 400 years, architects in Europe and other continents developed many new styles. The Europeans took some of their styles to America, Africa, Asia and Australia. For a description of these styles, see **Architecture.**

In the 1800's and 1900's, the demand for houses increased, as populations in many countries began to increase rapidly. Scientists and engineers produced many new building materials and methods. Factories mass-produced parts that had previously been handmade. Architects could design houses with completely new forms, using such materials as steel, reinforced concrete, plate-glass, and plastics. In the 1900's, modern styles of house design were used in almost every country of the world. A new house built in Japan might look much like one built in Denmark.



A half-timbered house of the 1400's had wall frames of *wattle and daub*—timber filled with a mixture of clay, lime, and water laid on woven sticks.

In the 1950's, designers developed *system building.* In this method of house construction, builders use large factory-built units, such as wall and roof frames and panels. As a result, houses can be built extremely quickly by assembling the units on the site. These methods have been widely used in many countries, but traditional house-building methods continue to be favoured by many house-buyers.

Related articles in ***World Book*** include:

Air conditioning
Architecture
Brick
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Building stone
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Insulation
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Plaster
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Shelter
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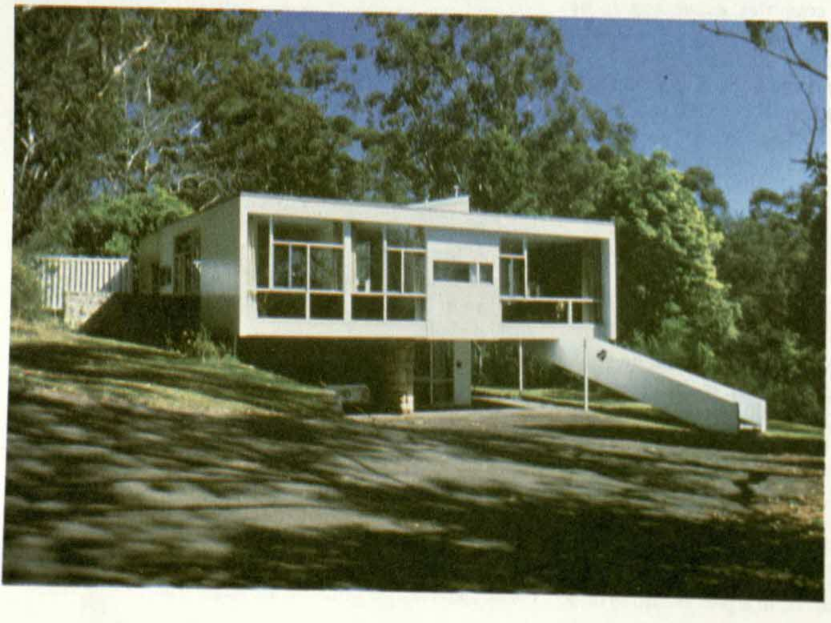


Modern houses are built from materials such as steel and reinforced concrete, like this house designed by Harry Seidler at Turramurra in Sydney.

House of Burgesses was the first representative legislative body in America, and the first in any English colony. It first met at Jamestown, then the capital of Virginia, on July 30, 1619. Governor Sir George Yeardley called the meeting. The session included two citizens, or *burgesses,* from each of the 11 *boroughs* (subdivisions) of Virginia.

The first act of the body was to approve an official great seal for the colony. The House also claimed the right to act on all tax laws. In 1621, the House received the authority to make all legislation, but the governor and his council had the right of veto. The House conformed to English law and used the same procedure as the English Parliament.

After the death of King James I in 1625, the English government became occupied with its internal affairs. England neither approved nor disapproved of the House. From then on, the House managed the affairs of the colony. The failure of Governor Sir William Berkeley to call a new election to the House was one of the many grievances that led to Bacon's Rebellion against the government in 1676.

The House of Burgesses was not completely democratic. But it was the first appearance of republican government. When it was temporarily dissolved in 1774, its members met in the first revolutionary convention of Virginia. There they elected delegates to the First Continental Congress. Some of the burgesses became leaders of the American Revolution.

House of Commons is one of the two houses of Parliament, the lawmaking body of the United Kingdom. The House of Lords is the other. The House of Commons is the more powerful house.

A majority of the members of the House of Commons must approve all bills before they can become law. Finance bills passed by the House of Commons become law one month after being sent to the House of Lords, whether that House approves them or not. Other bills passed by the House of Commons in two consecutive sessions automatically become law, regardless of the vote in the House of Lords.

Members of the House of Commons are elected from each of the four countries of the UK. The House has 651 members—524 from England, 72 from Scotland, 38 from Wales, and 17 from Northern Ireland. Each member represents a voting district called a *constituency.* The members do not have to live in the constituency they represent.

Officials of the Church of England, the Church of Scotland, the Church of Ireland, and the Roman Catholic Church cannot be elected to the House of Commons. Members of the nobility—except peers of Ireland—and certain government employees are also ineligible for election to the House of Commons.

Members of the House of Commons do not serve a fixed term. They are chosen in a *general election,* in which the entire nation votes. General elections must be held at least every five years. If a member of the House of Commons dies or resigns, a *by-election* is held in the constituency.

See also **United Kingdom** (Parliament); **Parliament** (The House of Commons).

House of Lords is one of the two houses of Parliament, the lawmaking body of the United Kingdom. The House of Commons is the other house and is more powerful than the House of Lords.

The main function of the House of Lords is to examine bills passed by the House of Commons. The House of Lords often amends bills but rarely challenges their basic principles. After the House of Commons has approved a bill, the House of Lords may delay the measure but cannot defeat it.

The House of Lords has about 1,170 members. About 800 members are *hereditary peers,* nobles who inherit their titles. About 320 members are *life peers,* persons given the rank of baron or baroness to honour their achievements in business, civil service, or other fields. Twenty *law lords* are selected from the nation's highest-ranking judges. These members hear final legal appeals. The *lords spiritual* are 26 senior officials of the Church of England. About 20 per cent of all members attend most debates.

Parliament was divided into the House of Lords and the House of Commons during the 1300's. The houses had nearly equal power until 1832, when a reform act took away much of the power of the House of Lords. The Parliamentary Acts of 1911 and 1949 further limited the actions of the House of Lords.

See also **United Kingdom** (Parliament); **Parliament** (The House of Lords).

House of Representatives is one of the two lawmaking bodies of many legislatures. In many of these legislatures, the other chamber is called a *senate,* or upper house, and the house of representatives is the larger of the two. It is made up of members elected by the people. About half of the world's countries have a two house legislature. Names for the lower house include Chamber of Deputies, House of Commons, and National Assembly. In most countries, representatives in the lower chamber each come from a *constituency* which has a population close to a standard size. Generally, the lower house has more power than the upper chamber.

Australia's House of Representatives has 148 members. The United States House of Representatives has 435 members. Members of lower houses serve terms that range from two years to six years. Some countries have special government articles in *World Book,* such as **France** (Government), or **Australia, Government of.**

See also **Government; House of Commons; Senate; Speaker:**

House plant. See **Gardening** (Kinds of indoor gardens; Cultivating an indoor garden).

House sparrow. See **Sparrow.**

Houseboat is any kind of floating home. People may own or rent houseboats on lakes and rivers.

Houseboats vary in length from 7 to 10 metres, and some are more than 15 metres long. The hull can be made of several materials, including plywood, fibreglassed plywood, aluminium, steel, or a combination of aluminium and steel. Most houseboats are small and simply furnished. But some have several rooms, with all the conveniences of the modern home, including a cooker, refrigerator, running water, hot-water heater, and electric lights.

Most houseboats must be towed from place to place. But many modern houseboats are designed to remain in the water all year. A houseboat may have retractable

Houseboats on Dal Lake in Kashmir, India, are used as holiday homes. They have many rooms, all fully furnished.

wheels, and also serve as a house trailer. Many houseboats have engines. They usually have a maximum speed of about 20 kilometres an hour.

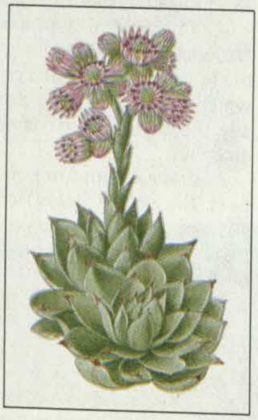
In some regions of the world, houseboats provide homes for many persons. In parts of China, thousands of people live on river boats all their lives. They buy their supplies from floating shops.

See also **Asia** (picture: Floating homes); **Sampan.**

Housefly. See Fly.

Houseleek, also called *live-forever,* is a group of succulent plants related to the sedums. Their fleshy leaves tend to form thick rosettes. Their star-shaped flowers grow on stems up to 30 centimetres tall and are greenish-white, rose, yellow, or purple. The *common houseleek* grows wild on Alpine rocks. This plant also thrives around houses throughout Europe, where it is used as a cover for walls and roofs.

The cut or bruised leaves of the houseleek are said to relieve the pain of burns and bee stings. People once thought that the houseleek protected against lightning, and called it *thunder plant.*



Houseleek

Scientific classification. Houseleeks belong to the orpine family, Crassulaceae. The common plant is *Sempervivum tectorum.*

Substandard housing. Millions of people throughout the world live in run-down, unsanitary, or overcrowded dwellings.

Housing includes any kind of building that provides shelter for people. In a broader sense, it is planned provision of homes and concerns itself with problems of city planning, and community services that provide good living conditions.

Safe, sanitary, comfortable dwellings are called *standard housing.* Housing that has proper heating and ventilation helps people stay in good health. Good housing provides enough space for every member of the family to have some privacy and freedom. Standard housing includes hot and cold running water and a well-planned sewage disposal system. It also provides electric light at night and lets in plenty of sunlight by day.

Poorly constructed, run-down, unsanitary, or overcrowded dwellings are called *substandard housing.* Using this definition, most of the world's people live in substandard housing. Many people in Europe's less industrialized countries are badly housed. Throughout Asia, Africa, and Latin America, millions of people live in crude dwellings that barely provide shelter. Around many of the major cities in these countries stand large areas of substandard dwellings which house rural people who have moved to the cities in search of work. A *household* is made up of all the people living in one housing unit.

A neighbourhood with many substandard buildings is called a *slum.* The older, central areas of cities often deteriorate and become slums. Most occupants of slums have low incomes, and several families may live in one dwelling unit. As a neighbourhood begins to decline, many of its residents who can afford to move to better areas do so. Their old homes may be taken over by persons moving into the city who cannot afford better housing.

Most slums have high rates of illness, disease, and crime. Slums also have inferior community services, including poor schools, inadequate police and fire protection, infrequent refuse collection, and too few parks and playgrounds. Some financial institutions refuse to make mortgage or home-improvement loans in neighbourhoods they consider to be declining. This practice may speed the development of slums by preventing the purchase or repair of houses in such neighbourhoods. However, legislation has been passed in some countries to discourage this practice.

Prejudice and discrimination prevent many members of minority groups from having adequate housing. In many Western countries, nonwhites, Jews, and immigrants have been forced to live in slums or segregated areas known as *ghettos.* Increasingly, legislation has been used to try to eliminate such conditions and to make good housing available to all.

Private housing projects are groups of buildings erected at the same time for several hundred or several thousand families. A housing project may have a group of small houses which will be built much alike to save costs, a group of town houses, blocks of flats, or a mix of all three.

Local governments often encourage large insurance companies or other institutions to build communities of homes and flats. Some cities and states grant such companies special tax reductions on the property. Or they may clear the land to rid it of slums and then sell it to a private developer.

Suburban developments. Most housing erected by individuals or private contractors is built on vacant land on the outskirts of cities and towns. Vacant land generally costs less in outlying areas, and there are no buildings that must be destroyed before construction can begin. Most of these new dwellings are one-family houses on plots of up 0.2 hectare, and are bought by the families who move into them.

Every year, thousands of families move into newly built suburban homes. Entire new communities have been built with shops, cinemas, schools, churches, and parks. Many big city stores have branches in shopping centres in these communities.

New towns. In some cases, the growth of cities has taken the form of developments called *new towns.* Such planned communities are more complex than are suburban developments. Unlike most residential suburbs, new towns include factories and industries, and many of the residents both work and live in the community.

Housing blocks can be arranged so that they seem separate. In a housing project in Montreal, Canada, *above,* each block was *prefabricated* (completed before it was set in place).

Blocks of flats like these in the Brooklyn borough of New York City are the homes of millions of people. Most tall apartment buildings are located in heavily populated areas, where land is scarce and expensive.

Cooperative housing. People sometimes form non-profit-making corporations to plan, finance, build, and manage the flats or houses in which they live. When a cooperative builds or buys a block of flats, individuals buy shares in the corporation. The shares entitle them to occupy flats, but not to own the units. They share the expense of maintenance, repair, and improvement for the entire building.

Condominium housing, a form of housing common in the United States of America, resembles cooperative housing, with one important difference. In condominium housing, the occupants each own their own dwelling units, and each has a share in the parts of the building used by all occupants. They share expenses only for those parts and services of the building that all of them use. If one or more occupants fail to meet their financial obligations toward their own units, the other occupants are not affected. In cooperative housing, all shareholders are responsible if some occupants fail to meet their financial obligations.

Early slab houses in Australia were built by pioneers using tree trunks that were squared with an adze.

Low-income and assisted housing

Many people cannot afford the rents or mortgage payments for standard housing. Many governments have established programmes to provide assistance for low-income families.

Public housing for low-income families has traditionally been provided by city housing *authorities* (organizations). The authority determines the need for public housing and then plans, develops, and manages the projects. In many cities, the demand for public housing exceeds the supply.

Public housing may be provided in several ways. The authority may build new housing or buy it from a developer. It may buy existing housing and restore it to good condition. Alternatively, the authority may lease existing housing.

Local housing controls

Building codes in many countries control the construction of new dwellings. They require that new structures be sturdily built, provide reasonable room sizes, and receive ample light and air.

Housing codes have been adopted by many cities to insure that older housing is maintained in good condition. These codes require housing to have adequate lighting, ventilation, exits, heating, water, toilets, and refuse and waste disposal. The codes require owners to keep housing sanitary, to remove fire hazards, and to keep the building in good repair. Many housing codes limit the number of people who may sleep in one room.

History

The Industrial Revolution, which began in the 1700's, produced much unplanned city development. Thousands of people moved to cities to find work, and builders put up almost any kind of housing to meet the demand. Many businesses, factories, and houses stood side by side on narrow streets. Blocks of tenement houses appeared in large cities of the United States, France, Great Britain, and other industrial countries during this period.

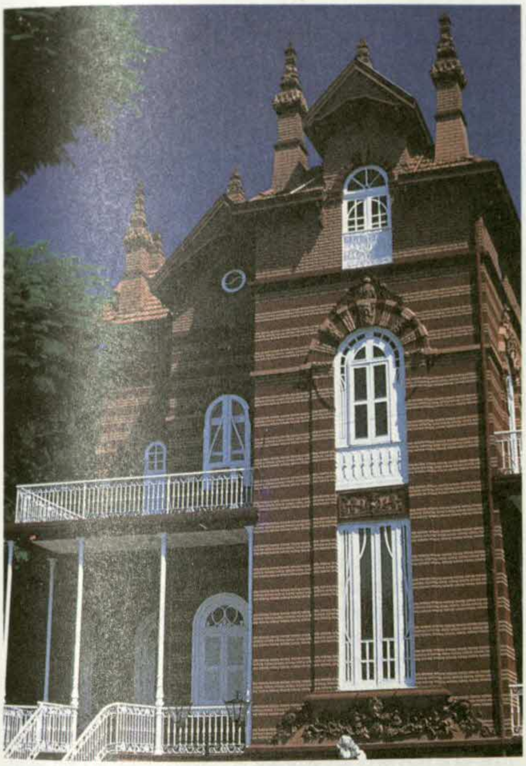
By the 1900's, a world housing shortage existed, chiefly because of the population increase and the concentration of the population in urban areas. The expansion of industry, a shortage of construction workers, and a lack of money for new housing also helped cause the housing shortage.

Housing since 1900. New housing construction fell to inadequate levels during World Wars I and II because builders lacked materials. During the Great Depression of the 1930's, people had little money for building. During the 1960's, more and more families moved from rural areas to cities to find work, causing serious housing shortages in spite of stepped-up housing construction.

Millions of homes were damaged or destroyed throughout Europe during World War II (1939-1945). Since then, much of the housing built in Europe consists of government-owned blocks of flats that are rented at low cost. They provide all the basics, including hot and cold running water, heat, electricity, and separate rooms for parents and children of each sex. Large numbers of people in almost every class of citizen, from unskilled worker to professional, live in housing provided by the government.

China has about a billion people, most of whom live in eastern China. The soil is fertile there, and so housing competes for space with valuable farm land. Thus, China can provide its people with only the most minimal housing. If running water is available, it is most often a single tap providing cold water. Toilets and bathing facilities are shared by many people. In the mid-1980's, the Chinese government began massive new housing programmes.

A traditional thatched house in Madeira.



A richly decorated house stands in the old section of Bélem, Brazil.

In India and South Asia about four-fifths of the people live in rural villages. In the towns, the British influence is still seen in the pattern of urban development. Some old cities have alongside them the *cantonments,* the military accommodation for officers and men, which now make up the suburban homes of the middle class. The advent of the Industrial Revolution in India in the 1800's brought about the migration of many rural people to the cities and the beginning of severe overcrowding. It was not until the mid-1900's that new towns were built, such as the garden cities of Lahore and Bangalore. High rise blocks of flats in the big cities are spacious and air conditioned. However, these are available only to the very rich. For poorer people, housing is frequently substandard, without electricity or individual water supplies.

Related articles in *World Book* include:

Architecture
Building construction
Hill, Octavia
Homelessness
Hotel
House
Houseboat
London (pictures)
Mortgage
Motel
Sanitation
Segregation
Shelter
Tenement

Housman, A. E. (1859-1936), was a British poet and scholar. He wrote melancholy lyrics about human suffering. His outlook on life was pessimistic, and his poems express the fleeting quality of love and beauty. He published only two books of verse: *A Shropshire Lad* (1896) and *Last Poems* (1922). However, after his death, his brother Laurence published *More Poems* (1936), *Collected Poems* (1939), and *Manuscript Poems* (1955).

Alfred Edward Housman was born in Fockbury, Worcestershire, England. He was a classical scholar, and he taught Latin at the University of London and at Cambridge University.

Houston (pop. 1,630,553) is the largest city in Texas and one of the fastest-growing major cities in the United States. In 1940, Houston ranked 21st in population among U.S. cities. By 1990, it had jumped to 4th.

Houston lies in southeast Texas, about 80 kilometres from the Gulf of Mexico. In spite of its inland location, Houston is one of the world's major seaports. The Houston Ship Channel links it to the Gulf of Mexico and permits ships to sail to and from Houston.

Houston is a major industrial city. The region contains rich oil deposits. Houston also serves as a centre of the United States space programme. Space flights are directed from the National Aeronautics and Space Administration's Lyndon B. Johnson Space Center at Houston.

Economy. The production of chemicals—especially *petrochemicals*—and oil refining rank as Houston's chief industries. Petrochemicals are chemicals made from crude oil or from natural gas. Petrochemicals produced include benzene, ethylene, and propylene.

Houston is also a leading manufacturer of fertilizers, insecticides, and oil field equipment. The Port of Houston handles about 73 million metric tons of cargo a year. It employs hundreds of dockworkers and helps to make Houston an industrial centre.

History. Before white settlers arrived, Karankawa Indians lived along the Gulf Coast near what is now Houston. About 1914, major oil discoveries in southeast Texas led several oil companies to build refineries in the Houston area. World War II (1939-1945) increased the demand for Houston's petroleum products.

The Manned Spacecraft Center established its quarters in the Clear Lake City area near Houston in 1964. In 1969, scientists and engineers at the centre directed the first landing of astronauts on the moon. The centre was renamed the Lyndon B. Johnson Space Center in 1973.

During the 1970's, Houston continued its growth in industry, trade, and population. More than 200 corporations moved their headquarters to the city or established divisions or subdivisions there. Between 1970 and 1980, the city's population increased from 1,233,535 to 1,595,138. In 1977, Houston annexed Clear Lake City, which lies next to the Lyndon B. Johnson Space Center. The 1980 U.S. Census reported that Houston had become the nation's fifth largest city in population.

Houston's rapid growth led to increased air and water pollution, particularly from industries along the Houston Ship Channel. But during the late 1960's and early 1970's, city officials introduced programmes that significantly reduced the pollution, especially water pollution. Until the late 1970's, Houston did not have adequate public transportation. In 1979, the Metropolitan Transit Authority was created to provide public transportation throughout the area.

Between 1970 and 1980, the number of housing units in the Houston area increased by about 70 per cent. Most of the residential growth occurred in Houston's suburbs. Also, a construction boom took place in central Houston, and the office space in the business area nearly tripled.

During the 1980's, Houston plunged into a recession brought on by a decline in oil prices. City leaders then worked to bring greater variety to the economy. They hoped that the city would become less dependent on oil for its economic health. By 1990, Houston had become the fourth largest city in the United States.

Houston, Sam (1793-1863), played a leading part in Texas's fight for independence from Mexico. He later served as president of the Republic of Texas and, after Texas joined the Union, as United States senator and governor of the state.

Houston was born in Virginia, U.S.A. He moved west to Texas to become an Indian trader. Texas was then a part of Mexico, but the Americans who settled there did not get on with the Mexican government. Houston became one of their leaders. In 1836, he organized a Texas army and became its commander in chief.

Houston led his troops in a series of battles against the forces of the Mexican general Antonio de Santa Anna. In October 1836, Houston was elected the first president of the new Republic of Texas.

Houston worked to have Texas admitted to the United States. He succeeded in 1845, and from 1846 to 1859 he served as United States senator from Texas. But, in 1861, Texas voted to secede. Houston then retired to private life. He died in Huntsville, Texas.

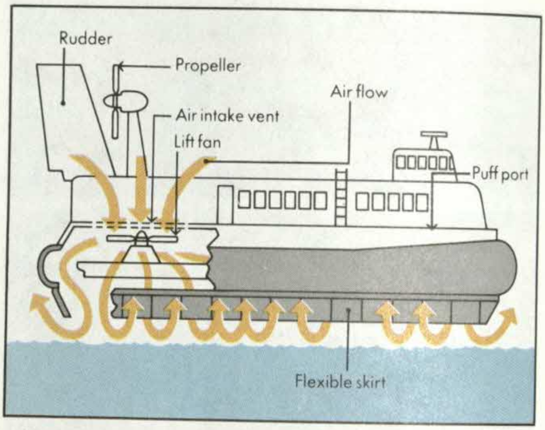
Houtman, Frederik de, was a Dutch navigator who ran aground off the western coast of the Australian continent in 1619. He was captain of the *Dordrecht.* He named the Houtman Abrolhos Islands and explored the mainland. On his return to Batavia (now Jakarta, Indonesia), he reported unfavourably about the area. Historians know little about his life.

Hove (pop. 82,500) is a local government district and holiday resort on the East Sussex coast of England. It is situated close to Brighton. Hove's beach comprises mainly shingle. The town has parks and pleasure grounds and many fine Regency houses. The museum has Roman remains from Southwick, in West Sussex. The Sussex county cricket team plays many matches on the cricket ground at Hove. See also **Sussex.**

Hovell, William (1786-1875), an Australian explorer, became famous for his discovery in 1824 of a direct land route from Lake George, south of Sydney, to Bass Strait. He was travelling with Hamilton Hume. Hovell returned to Port Phillip Bay with another party in 1826. He was born in Yarmouth, England. He was a ship's captain, and he landed in Sydney in 1813.

See also **Hume, Hamilton.**

hovercraft can travel on land or on water. The vehicle shown bove is a United States Navy hovercraft. The Navy uses hoverraft for patrol duty and rescue missions.



A "cushion" of air under pressure supports a hovercraft. A powerful fan creates the cushion by blowing air beneath the craft's flexible skirt. A propeller drives the craft forward. The pilot steers the vehicle with an aeroplane-type rudder.

Hovercraft is a craft that travels on a layer of compressed air just above any kind of surface—land or water. The compressed air serves as an invisible cushion that eliminates almost all friction between the vehicle and the surface. Hovercraft, which are also known as *air cushion vehicles* (ACV's), can carry passengers, vehicles, and freight. Some hovercraft can travel as fast as 130 kilometres per hour.

How a hovercraft works. A hovercraft has one or more fans that suck air into the craft. The fans force the air underneath the vehicle, creating an air cushion between the vehicle and the surface. Hovercraft are sometimes called *ground effect machines* because they use the surface to help trap the air.

A flexible rubberized skirt surrounds the lower edge of most hovercraft. It fills with air forced in by the fans. The skirt enables the vehicle to travel over such rough obstacles as rocks and waves. Some hovercraft have skirts only across the bow and stern. Rigid sidehulls run along the length of the craft. Such vehicles are called *surface effect ships* (SES's). They can be used only in the water.

Gas turbines or lightweight diesel engines provide the power for the fans, and propellers drive the vehicle forward. Most hovercraft have small doors called *puff ports* and either rudders or propellers for steering. These enable the vehicle to travel backward, forward, or sideways, or to hover or turn.

History. Air cushion principles were recognized as early as the mid-1800's, but the technology did not exist for building a practical model. In the early 1900's, a limited number were built. The Austrian Navy demonstrated one in 1916. In the mid-1950's, Christopher Cockerell, an English inventor, improved the basic design. In the early 1960's, Japan, the United Kingdom, the United States, and other countries all tested hovercraft at various times.

In the late 1960's, the U.S. Navy and Army began to use hovercraft in the Vietnam War for patrol duty and rescue missions. In 1968, the British began to use hovercraft to carry passengers and cars across the English Channel. Development of *hoverbarges*—that is, hovercraft that are pulled or pushed by another vehicle—began in the 1960's. In 1972, Canadian researchers discovered that hovercraft could be used to break ice on waterways.

Today, manufacturers produce a number of models that vary in size, speed, and power. Modern hovercraft accomplish many tasks, but most are used for military missions. Russia and the United States are the world's largest users of the craft.

In the late 1950's, Jean Bertin, a French engineer, invented a special train called a *tracked hovercraft* or *air train.* This train runs only on land, and it requires tracks. It does not actually touch the tracks, but uses them as a guide. An air cushion keeps the train above the tracks. The train has a *linear electric motor,* which includes electromagnets in the underside of the vehicle (see **Linear electric motor**). The train is powered by magnetic forces between the track and the electromagnets. It may also be powered by a jet engine.

A vehicle called a *magnetic levitation* (maglev) train resembles the tracked hovercraft. However, a maglev train relies on a magnetic force between the vehicle and the guide rail—rather than on a cushion of compressed air—to hold the vehicle above the guideway.

Hovhaness, Alan (1911-), is an American composer. He became known for works that reflect his Armenian ancestry and his interest in Oriental music. By the early 1990's, he had composed almost 400 works, most of them instrumental, each lasting less than 20 minutes. His instrumental music includes 62 symphonies, 8 concertos, and chamber music. He has also written eight operas and music for solo instruments and voices. Most of his orchestra works feature up-and-down sliding string passages with the range frequently indicated but not the exact notes.

Hovhaness incorporated traditional Armenian songs and dance music in *Armenian Rhapsody No. 1* (1944) and other compositions. He gave several of his symphonies Armenian names, such as *Etchmiadzin* for Symphony No. 21 (1970). His interest in the music of India appears in *Varuna* (1973), a string trio; and *Shambala* (1967), a concerto for violin, sitar, and orchestra. The influence of Japanese music can be heard in *Fantasy on Japanese Woodprints* (1965) for xylophone and orchestra. He used taped sounds of the humpback whale in *And God Created Great Whales* (1970) for orchestra. Hovhaness was born in Somerville, Massachusetts.

Howard, Catherine. See **Henry** (VIII, of England).

Howard, Henry. See **Surrey, Earl of.**

Howard, John (1726?-1790), a British prison reformer, was apprenticed to a London grocer as a young man and inherited a fortune at the age of 25. He built quality cottages for his workers, but did not begin his reform work until his appointment as High Sheriff of Bedfordshire in 1773. In this job, shocked by what he found in prisons, he began a monumental study called *The State of the Prisons in England and Wales* (1777). It led Parliament to correct many abuses.

To keep his study up to date, Howard visited every prison in the country four times. He also visited prisons and plague hospitals throughout Europe, measuring rooms, inspecting kitchens, and talking with inmates. Howard died while he was on a tour of military hospitals in Russia.

Howard spent his entire fortune on his remarkably thorough work. He refused to be sidetracked, and forced reforms by the objectivity of his evidence. He refused personal glory for his work. He was born in London.

The John Howard Association, a U.S. prison-reform group founded in 1901, was named after him. It works to improve prison conditions and help prisoners and ex-convicts. A similar group in the United Kingdom is called the Howard League for Penal Reform.

Howard of Effingham, Lord (1536-1624), commanded the English fleet that defeated the Spanish Armada in 1588 (see **Spanish Armada**). As Charles Howard, he became ambassador to France and a member of Parliament. In 1573, he succeeded his father as Baron Howard of Effingham. After 1585, he was lord high admiral of England. In 1596, he was made Earl of Nottingham for his part in a naval raid on the port of Cádiz with the Earl of Essex. Five years later, he crushed Essex's rebellion against Queen Elizabeth I. Howard continued to hold high offices under James I.

Howe is the family name of two American social reformers, husband and wife.

Samuel Gridley Howe (1801-1876) worked in many areas of reform. In 1824, he went to Greece to help that country in its war against the Turks. He served there as a soldier and surgeon, and helped give relief to the war-torn people. He then returned to Boston, Massachusetts, and in 1832 became the first director of the New England School for the Education of the Blind (now Perkins School for the Blind), the first such institution in the United States. Howe directed the school until his death on Jan. 9, 1876.

Howe also helped Horace Mann in his work on education, and Dorothea Dix in her work with the mentally ill. He and his wife, Julia Ward Howe, edited *The Commonwealth,* a Free Soil paper. Howe helped rescue fugitive slaves and raised money to keep Kansas a Free Soil state. He served in the federal government both during and after the Civil War. He was born in Boston. See **Abolition movement.**

Julia Ward Howe

Julia Ward Howe (1819-1910), a writer, lecturer, and reformer, wrote the words of "The Battle Hymn of the Republic." She introduced the idea of Mother's Day (see **Mother's Day**). She was one of the most famous American women of her time.

Mrs. Howe was born into a prominent New York City family. She married Samuel Gridley Howe in 1843 and moved to Boston. She wrote poems, plays, and helped Howe edit *The Commonwealth.*

In 1861, after the Civil War started, she visited military camps near Washington, D.C. There she was inspired to write "The Battle Hymn of the Republic" to the tune of "John Brown's Body." It was published in the *Atlantic Monthly* the next spring and became the major war song of the Union forces.

After the war, Mrs. Howe became increasingly interested in reforms. In 1868, she helped organize the New England Woman's Club, and served for many years as its president. She also served as the first president of the New England Woman Suffrage Association. She was interested in world peace and led the American section of the Woman's International Peace Association.

Mrs. Howe became noted as a lecturer and writer on literary and other cultural topics as well as on woman's rights. Her writings include *A Trip to Cuba* (1860), *Sex and Education* (1874), *Modern Society* (1881), *Margaret Fuller* (1883), and *Reminiscences* (1899).

Howe is the family name of two British brothers who fought for Britain in the American Revolution.

Richard Howe (1726-1799), Earl Howe, was a famous naval officer. He joined the British Navy at the age of 14 and rose steadily in rank. At the start of the American Revolution, he was made vice admiral. In 1776, he took command of the British fleet in America.

At the end of the war, Howe became First Lord of the Admiralty. When England and France went to war in 1793, he took command of the Channel Fleet. The next year, he won the victory known as "the glorious first of June," and King George III made him a Knight of the Garter. Howe was promoted to the rank of Admiral of the Fleet in 1796. He was born in London.

William Howe (1729-1814), Viscount Howe, the younger brother of Richard Howe, saw his first military service in Flanders at the age of 17. During the Seven Years' War (1756-1763), he fought at the siege and capture of Louisbourg, and in the Battle of Quebec.

Three years before the American Revolution began, he was promoted to the rank of major general. In May 1775, Howe joined General Thomas Gage in Boston. He led the British in the Battle of Bunker Hill, and in October 1775, succeeded Gage as commander of the British army in America. He won the battles of Long Island, White Plains, and Brandywine, and occupied Philadelphia. But he did not accomplish the defeat of the American cause, and in 1778 was succeeded by Sir Henry Clinton. Howe was knighted in 1776. He was promoted to general in 1793.

See also **American Revolution.**

Howe, Elias (1819-1867), an American inventor, constructed a practical sewing machine. He patented it in 1846. After a difficult but successful defence of his patent, he made a fortune. Howe's sewing machine symbolized the important role in American industry of increasing mechanization during the 1800's.

Howe was born in Spencer, Massachusetts. As a young man, he went to Boston to learn the machinist trade. While apprenticed to a scientific-instrument maker in Cambridge, Massachusetts, he overheard a remark that the person who produced a workable sewing machine would make a fortune. In 1845, he finished a machine that sewed 250 stitches a minute, but he failed to find a market for it.

Howe went to England and sold British rights to the machine. He returned to the United States in 1849. While Howe was in England, others, including Isaac Singer, started manufacturing sewing machines. After a long and determined campaign, Howe established in 1854 his right to collect royalties on all machines manufactured.

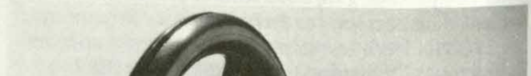
See also **Sewing machine** (History).

Howe, Michael (1787-1818), was a *bushranger* (an escaped convict living in the Australian bush). He was born in Yorkshire, England. Transported for highway robbery, he arrived in Van Diemen's Land (now Tasmania) in 1812. Howe escaped into the bush in 1814 and joined the large gang of bushrangers led by John Whitehead. It was one of the most murderous and callous bushranging gangs in Australian history. Whitehead was killed by soldiers in 1814, and Howe took command of the gang. Using disciplinary methods he had learnt in the navy and army, Howe turned the gang into a formidable force. Howe was also one of the earliest bushrangers to create a telegraph made up of friends and well-paid informants to keep him in touch with the movements of the authorities.

Robbery, murder, and rape were all crimes attributed to Howe and his gang. But the authorities could not catch them. In 1817, the lieutenant governor offered Howe an amnesty or pardon if he would surrender himself and provide information on his gang members. Howe went to Hobart for negotiations, but reconsidered and returned to the bush. In 1818, he was killed by a spy planted in the gang.

Howe, Sir Geoffrey (1926-), a Conservative politician, was Britain's deputy prime minister from 1989 to 1990. He had been foreign secretary since 1983. Before that, Howe had been solicitor general from 1970 to 1972, minister for trade and consumer affairs from 1972 to 1974, and chancellor of the exchequer from 1979 to 1983.

Richard Edward Geoffrey Howe was born in Port Talbot, West Glamorgan, Wales. He was educated at Winchester College and Cambridge University. After military service, he became a barrister. Howe was first elected to Parliament in 1964. He received a life peerage in 1992, taking the title Lord Howe of Aberavon.



An early sewing machine invented by Elias Howe. His invention made Howe a rich man.

Howells, William Dean (1837-1920), was an American novelist, editor, and critic. He attacked sentimentality and romanticism in American fiction and played an important part in the rise of the realism movement in the United States (see **Realism**).

Howells was born in Martins Ferry, Ohio. In 1861, U.S. President Abraham Lincoln appointed him U.S. consul in Venice, Italy. The appointment was a reward for writing the biography *Life of Lincoln* (1860). Howells lived in Venice until 1865 and described his experiences there in his first important work, *Venetian Life* (1866). This book of sketches brought Howells immediate recognition. In 1866, he became a member of the staff of the *Atlantic Monthly* magazine. Howells served as editor of the *Atlantic* from 1871 until he resigned in 1881.

Howells wrote his best novels after he left the *Atlantic*. Each of these novels deals with various issues of the day in an increasingly realistic manner. *A Modern Instance* (1882) concerns the then daring subject of divorce. *The Rise of Silas Lapham* (1885) is generally considered Howells' finest work. It describes the rise of a businessman in a society controlled by families who inherited positions of influence and power. *A Hazard of New Fortunes* (1890) portrays the problems of industrialization and the growth of trade unions.

Howells' influence as an editor and critic was perhaps even greater than as a novelist. As editor of the *Atlantic*, he helped introduce European writers—especially new realists—to American readers. He challenged American writers to choose American subjects, to portray them honestly, and to create characters who used native American speech.

Howells also wrote columns in *Harper's Monthly* called the "Editor's Study" (1886-1892) and the "Editor's Easy Chair" (1900-1920). In these columns, he campaigned for literary realism that examined life with scientific detachment. He helped introduce and support such realistic writers as Stephen Crane, Bret Harte, and Mark Twain. His essays describing his literary standards and ideas were collected in *Criticism and Fiction* (1891) and *My Literary Passions* (1895).

Howitzer. See **Artillery** (Kinds of artillery; pictures).

Howler is a large monkey that makes a loud, howling roar. It roars mostly at dawn, and also when two groups of howlers meet or when disturbed by noise or approaching rain. Its roar can be heard as far as 3 kilometres away. Howlers live in groups that generally have 15 to 20 members, but a group may have as few as 2 or as many as 45 monkeys. Howlers live in South American tropical forests from Mexico to Brazil.

Howlers weigh from 5.5 to 9 kilograms and grow to about 60 centimetres. Their long, powerful tails may also measure 60 centimetres. Various species of howlers have black, brown, or reddish fur.

Howlers move slowly through the trees, feeding as they go. They eat leaves, flowers, fruits, and nuts, using their hands to grasp the branches or stems from which they nibble. Howlers often swing by their tails while feeding. They seldom leave the trees. See **Animal** (picture: Animals of the tropical forests).

Scientific classification: Howlers are members of the New World monkey family, Cebidae. They make up the genus *Alouatta*. One common species of howler is *A. palliata*.

Hoxha, Enver (1908-1985), established a Communist government in Albania in 1944 and ruled the country until his death. He became known for his strong opposition to non-Communist countries. During the 1960's, Albania ended its relations with the Soviet Union and became a political partner of China. In 1978, relations between Albania and China became badly strained after Hoxha's government criticized China for improving its relations with non-Communist countries.

Hoxha was born in Gjirokastër, Albania. He founded the Albanian Communist Party in 1941. During World War II, he fought Italian and German forces in Albania. He led the Communist National Liberation Army, which fought non-Communist forces for control of Albania.

Hoyle, Edmond (1672-1769), was an English teacher of whist, a card game somewhat like bridge. In 1742, he published *A Short Treatise on the Game of Whist, containing the Laws of the Game*. Later, he added rules on other card games and on backgammon and chess. Hoyle's book became so famous that the expression *according to Hoyle* came to mean *according to the rules of the game*, or *in the proper way*.

Hoyle, Sir Fred (1915-), a British astronomer and cosmologist, gained fame for his theories of the origin of the universe. For many years, he advocated a theory of *continuous creation*, arguing that the universe is in a *steady state* in which matter and energy are continuously replaced as they dissipate. He strongly opposed the theory that the universe was created in one *big bang* at a single instant in time. His work has also been concerned with his theory that chemical elements originate in stars.

Sir Fred Hoyle

Hoyle was born in Bingley, in West Yorkshire, England. He was educated at Cambridge, where he later became Plumian professor of astronomy and director of the Institute of Theoretical Astronomy. In 1972, he became honorary research professor in physics and astronomy at Manchester University. He was knighted in the same year. In 1986, Hoyle published an autobiography, *The Small World of Fred Hoyle*.

Hsi Chiang. See **Xi Jiang**.

His-Ling-Shi. See **Silk** (History).

Hsun-tzu. See **Xunzi**.

Hu Yaobang (1915-1989), also spelled *Hu Yao-pang*, served as general secretary of the Chinese Communist Party from 1981 to 1987. (The general secretary was called chairman before 1982.) As general secretary, Hu held the highest post in the Communist Party, which controls the government of China. However, Deng Xiaoping was the country's most powerful leader (see **Deng Xiaoping**).

Hu Yaobang was born in Hunan province. He joined the Communist Party in 1933. During the 1940's, Hu served in the political department of China's rebel Communist army and became a friend of Deng. He became head of the Communist Youth League in 1952. He was removed from office during China's Cultural Revolution

(1966-1969). In 1973, Hu became an aide to Deng, who had become one of China's top leaders. In 1976, Deng and his associates, including Hu, were stripped of their power. Deng returned to power in 1977 and soon became China's top leader. Deng used his influence to help Hu become chairman of the Communist Party. Hu was removed from office in January 1987. Conservative Chinese leaders had criticized Hu for his liberal views on freedom of expression. But these views made Hu popular with citizens in China. Hu's death in April 1989 helped trigger large protests for more freedom. Hundreds of protesters were killed by the Chinese military (see **China** [China after Mao]).

Hu Yaobang

Hua Guofeng (1918?-), also spelled *Hua Kuo-feng,* was chairman of the Chinese Communist Party from 1976 to 1981. He also served as premier, China's top government post, from 1976 to 1980. Hua was one of the country's most powerful leaders until the late 1970's. Then, he lost most of his power and Deng Xiaoping became the most powerful leader in China (see **Deng Xiaoping**).

Hua resigned as premier in September 1980. In June 1981, he resigned as Communist Party chairman and became a vice chairman of the Communist Party. In 1982, the post of vice chairman was abolished. Also in 1982, Hua was dropped from the party's Politburo, China's main policymaking body. He then remained only a member of the party's Central Committee.

During the late 1970's, when Hua held power, China continued an earlier trend of improving relations with the United States. In 1979, the two countries established diplomatic ties for the first time.

Hua was born in Shanxi (or Shansi) province. Little is known about his early life. In 1955, he became the Communist Party secretary in the district of Hunan province. From 1958 to 1966, Hua served as one of the vice governors of Hunan. He remained a Hunan official during the Cultural Revolution (1966-1969), in which many Chinese leaders were *purged* (removed from office). In 1975, he became a vice premier of the State Council, the government's top administrative branch, and minister of public security.

Hua Luo-Yeng (1910-1985), a Chinese mathematician, was known for his work *The Theory of Prime Numbers in Dumps,* completed in 1941. It was published in English by the Academy of Sciences of the Soviet Union in 1946.

Hua Luo-Yeng was born in Jintan, Jiangsu Province. In his early years, he showed great talent in mathematics, which he studied on his own. In 1932, he began work as an assistant in Qinghua University. In 1936, he went to study at Cambridge University in the United Kingdom. He returned to China in 1938 and became a professor at South-west Associated University. In 1950, he was appointed director of the mathematics department in Qinghua University. In 1951, he became director of the Institute of Mathematics of the Chinese Academy of Sciences. In 1957, he was awarded the Chinese Academy of Science's top prize.

Huang He also spelled *Huang Ho,* is a long river in China. It is sometimes called *China's Sorrow* because of the many floods which brought death and hunger to the people living along its banks. The river is called *Huang He* (Yellow River) because it carries large amounts of soft yellow earth.

The Huang He is China's second longest river. Only the Yangtze is longer. The Huang He runs a course of 4,672 kilometres and drains an area of about 1,036,000 square kilometres. It rises in Qinghai Province and flows eastward until it empties into the Yellow Sea. The earth carried by the river is deposited in such large amounts at the river's bottom that it raises the bed and causes the river to change its course often. The Huang He cannot be used by ships because the upper part is too swift, while the middle and lower parts are too shallow.

The worst Huang He flood occurred in 1887, when the river overflowed an area of about 130,000 square kilometres. Nearly a million people died in this flood. Dykes have been kept up for hundreds of years to lessen the danger, but the river has never been completely controlled.

See also **Flood; China** (terrain map).

Huang Ho. See **Huang He.**

Huaraches. See **Mexico** (Clothing).

Huascarán. See **Andes Mountains** (with picture).

Hubble, Edwin Powell (1889-1953), was an American astronomer. His studies of galaxies helped explain the structure, size, and evolution of the universe.

Hubble was the first to demonstrate that the universe contains star systems other than our galaxy, the Milky Way. He identified certain stars in the Andromeda Nebula as being of the same type as some stars in the Milky Way. However, Hubble showed that the stars in Andromeda were beyond the calculated boundaries of our galaxy and that Andromeda was a separate galaxy.

Hubble later determined that all galaxies beyond the Milky Way are moving away from the earth. From this observation, he concluded that the universe is expanding. He also discovered that the galaxies that are farther from the earth recede faster than those that are nearer.

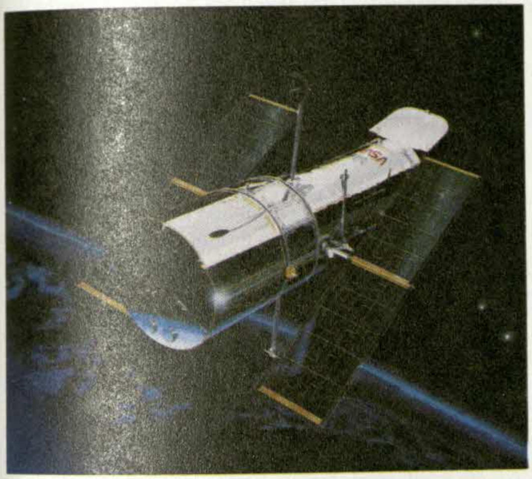
Hubble was born in Marshfield, Missouri. He earned a Ph.D. degree from the University of Chicago in 1917. In 1919, he joined the staff of the Mount Wilson Observatory in California, where he did most of his work as an astronomer.

See also **Astronomy** (Measuring distances in space; picture: Edwin Hubble).

Hubble Space Telescope is a reflecting telescope built as an orbiting observatory. Its main light-gathering mirror measures 240 centimetres in diameter. The United States space agency, the National Aeronautics and Space Administration (NASA), launched the telescope on a space shuttle in April 1990. The telescope is named after the American astronomer Edwin P. Hubble (see **Hubble, Edwin P.**).

The Hubble telescope orbits the earth about 580 kilometres above the surface. As a result, it escapes the effects of the earth's atmosphere. The atmosphere bends light from the stars and galaxies, and so blurs images.

In June 1990 scientists discovered that one of the two



The Hubble Space Telescope, an orbiting observatory launched in 1990, circles the earth high above the atmosphere.

mirrors of the telescope was manufactured to the wrong specifications. In 1993, astronauts replaced some lenses and installed a new camera to compensate for the flaw. Astronomers expect that observations made with the telescope will help them determine the size and age of the universe. They also plan to search for planets orbiting nearby stars. Astronomers have already used the Hubble telescope to find evidence for massive black holes located in the centre of one galaxy. The telescope also studies ultraviolet light, which is blocked by the earth's atmosphere.

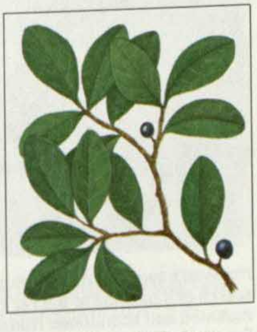
The Hubble Space Telescope is controlled by radio commands from the Goddard Space Flight Center in Greenbelt, Maryland, U.S.A. It transmits data by radio waves to astronomers on the ground.

See also **Telescope.**

Huckleberry is a small, round fruit that grows on a shrub. Huckleberries are black, blue, or red, and contain many hard seeds. They ripen in late summer and can be used in pies and jams. Huckleberry plants grow from 0.8 to 4 metres tall and sprout small flowers.

The most common huckleberries are *black huckleberries,* which grow wild throughout eastern North America. They thrive in partially shaded areas in peaty or sandy soil. *Blue huckleberries,* the sweetest type, are found chiefly along the Atlantic Coastal Plain of the United States. They grow in moist, peaty soil. Blue huckleberries have long, arching stalks. *Evergreen huckleberries* are common along the Pacific coast of the United States and Canada. Florists use the leaves and branches in bouquets.

Scientific classification. Huckleberries belong to the heather family, Ericaceae. The black huckleberry is *Gaylussacia baccata* and the blue huckleberry, *G. frondosa.*



Black huckleberry

Huddersfield has several attractive Victorian buildings. The Lion Arcade, *left,* in the centre of town, dates from the mid-1800's.

Huddersfield is a town in West Yorkshire, England, situated about 26 kilometres southwest of Leeds. It is the administrative centre of the local government district of Kirklees. Huddersfield is also an important manufacturing centre for the textile industry.

Engineering and the production of chemicals and dyes are among the other industries of Huddersfield. The Victoria Tower stands on Castle Hill, which is about 275 metres high. The Huddersfield Choral Society is one of the most famous choirs in the United Kingdom. This amateur choir was founded in 1836. Sir Malcolm Sargent was once its conductor. Huddersfield also has an annual festival of contemporary music.

See also **Kirklees** and **Yorkshire.**

Hudson, George (1800-1871), became known in the United Kingdom as the *Railway King* because of his ownership of many of the country's railways. At one point in his career, he controlled more than 1,600 route kilometres of railway. Hudson began speculating in railways in 1828, after inheriting £30,000. In the mid-1840's, he bought two railways that were losing money. Soon all his railways were in trouble and he went bankrupt in 1848.

Hudson was born near York. He was three times lord mayor of York and served as member of Parliament for Sunderland.

Hudson, Henry (? -1611), was an English explorer and sea captain. He made four voyages in an attempt to discover a northern route between Europe and Asia. Hudson never found such a sea passage, but he sailed farther north than any previous explorer. He explored three North American waterways that were later named after him—the Hudson River, Hudson Bay, and Hudson Strait.

Northern voyages. Historians know nothing about Hudson's life except for the period from 1607 to 1611, when he made his four voyages. In 1607, the Muscovy

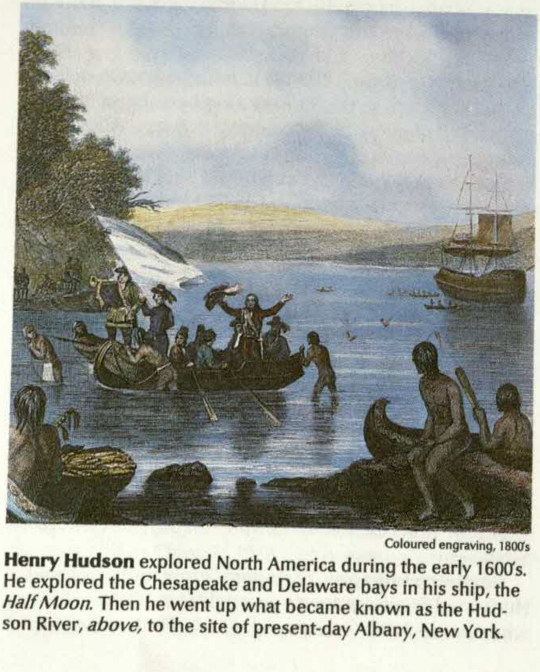
Company, an English trading firm, hired Hudson to find a northern sea route to Asia. European merchants and geographers believed that a ship could reach the Orient by sailing north, northeast, or northwest. They thought such a route would be shorter than any other. The Arctic had not been explored, and people did not know that ice blocked the area around the North Pole.

Henry Hudson

Hudson set out from England in a ship called the *Hopewell* with his young son, John, and a crew of 10 men. He sailed northeast along the coast of Greenland and reached Spitsbergen. These islands lie only about 1,100 kilometres from the North Pole, and no explorer had sailed so far north before. Huge ice floes forced Hudson to return to England. He told of seeing many whales in the northern waters, and his report led to English and Dutch whaling near Spitsbergen. In 1608, Hudson again tried to find a northern route, but ice again blocked the *Hopewell*.

North American voyages. The Muscovy Company lost interest in further northern exploration, but in 1609, the Dutch East India Company hired Hudson to lead an expedition. The company gave him a ship, the *Half Moon,* and a crew of about 20 men. Hudson again headed northeast, but his crew became unruly because of the cold weather. Hudson changed the ship's course for North America, crossed the Atlantic Ocean, and sailed down the east coast.

Hudson sailed as far south as what is now North Carolina. He then turned north and briefly explored Chesapeake Bay and Delaware Bay. Hudson travelled up what became known as the Hudson River to the site of present-day Albany, New York. Holland based its claims to land in North America on Hudson's third voyage.



Coloured engraving, 1800's

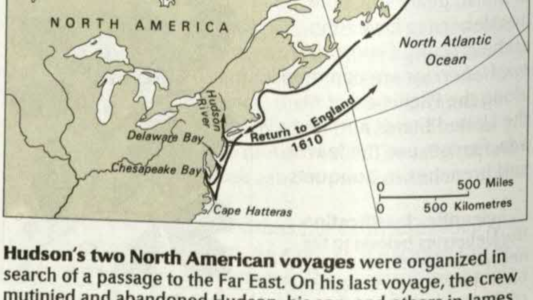
Henry Hudson explored North America during the early 1600's. He explored the Chesapeake and Delaware bays in his ship, the *Half Moon.* Then he went up what became known as the Hudson River, *above,* to the site of present-day Albany, New York.

In 1610, a group of English merchants formed a company that provided Hudson with a ship called the *Discovery.* He crossed the Atlantic and arrived just off the northern coast of Labrador. The *Discovery* then reached a body of rough water, later named Hudson Strait, that led into Hudson Bay. Hudson thought he had at last come to the Pacific Ocean, and he sailed south into what is now James Bay. But he failed to find an outlet at the south end of this bay. Ice forced the men to spend the winter there, and Hudson and his crew suffered severely from cold, hunger, and disease.

In the spring of 1611, Hudson intended to search for a western outlet from James Bay. But the crew mutinied and set Hudson adrift in a small boat with his son, John, and seven loyal crewmen. Hudson and his party were never seen again. The mutineers sailed back to England, and their report gave continued hope that a passage existed between Hudson Bay and the Pacific. England based its claim to the vast Hudson Bay region on Hudson's last voyage. Exploration of the region led to the establishment in 1670 of the Hudson's Bay Company, a fur-trading firm.

Hudson, Sir William (1896-1978), a New Zealand-born engineer, was the commissioner for the Snowy Mountains Hydro-Electric Authority, in Australia, from 1949 to 1967. He was involved in building many New South Wales dams, including the Nepean, the Woronora, and the Warragamba. He also supervised construction of dams in France, Scotland, and New Zealand. He was born at Nelson in the South Island. He was knighted in 1955.

Hudson, William Henry (1841-1922), was an English author and naturalist. Hudson grew up in Argentina. Most of his books are reports of personal experiences in bird watching and nature study in the remote regions of South America.



Hudson's two North American voyages were organized in search of a passage to the Far East. On his last voyage, the crew mutinied and abandoned Hudson, his son, and others in James Bay. Hudson and his party were never found.

Hudson's first book, the novel *The Purple Land* (1885), and his autobiography, *Far Away and Long Ago* (1918), are vivid accounts of life in Argentina. Both helped familiarize European and North American readers with the landscape and history of South America.

Hudson Bay is a vast inland sea in northeast Canada. It covers about 819,730 square kilometres.

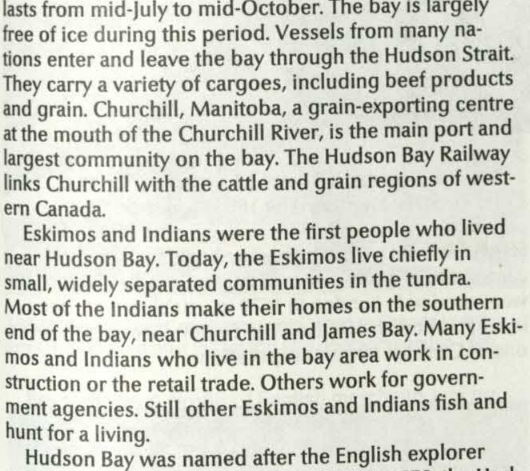
The bay, together with its southern arm, James Bay, is about 1,690 kilometres long and 1,118 kilometres wide. It has an average depth of 100 metres. Hudson Bay connects with the Atlantic Ocean through the Hudson Strait and with the Arctic Ocean through the Foxe Channel.

The land around the northern shore of the bay is part of a cold, flat, treeless area called a *tundra.* Forests grow to the south, and high, rocky bluffs rise on the east. In the west are flat, wet areas called *bogs.*

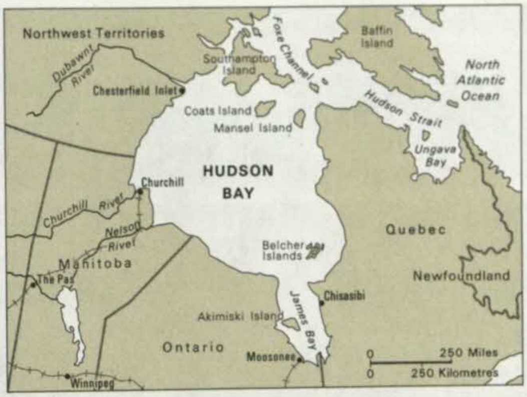
Shipping is the only important commercial activity in Hudson Bay. In most years, the shipping season usually lasts from mid-July to mid-October. The bay is largely free of ice during this period. Vessels from many nations enter and leave the bay through the Hudson Strait. They carry a variety of cargoes, including beef products and grain. Churchill, Manitoba, a grain-exporting centre at the mouth of the Churchill River, is the main port and largest community on the bay. The Hudson Bay Railway links Churchill with the cattle and grain regions of western Canada.

Eskimos and Indians were the first people who lived near Hudson Bay. Today, the Eskimos live chiefly in small, widely separated communities in the tundra. Most of the Indians make their homes on the southern end of the bay, near Churchill and James Bay. Many Eskimos and Indians who live in the bay area work in construction or the retail trade. Others work for government agencies. Still other Eskimos and Indians fish and hunt for a living.

Hudson Bay was named after the English explorer Henry Hudson, who reached it in 1610. In 1670, the Hudson's Bay Company, one of the earliest and largest fur-trading posts in North America, was founded by English merchants. The company eventually acquired full land and trading rights in the Hudson Bay area. This area included the bay and all of the lands drained by rivers that flowed into the bay. In 1870, the Canadian government purchased this territory from the Hudson's Bay Company and made it part of Canada.



Shipping on the Hudson Bay is the Canadian waterway's only important commercial activity. The dock shown above is in Churchill, Manitoba's chief seaport.



Location of Hudson Bay

Little development occurred in the bay area until 1971. That year, the province of Quebec began to build a group of hydroelectric stations on La Grande River, which flows into James Bay. Two stations were completed during the early 1980's, and a third was completed in 1986. These hydroelectric stations were the first part of a long-term development project.

See also **Hudson, Henry; Hudson's Bay Company.**

Hudson River is one of the most important trade waterways in the United States. At its mouth lies the harbour of New York City. In 1609, Henry Hudson became the first white person to explore the river, and it was named after him. The Hudson is sometimes called the *Rhine of America,* because some sections of its beautiful shores resemble the shores of the Rhine in Germany. The Hudson played an important part in U.S. history.

The Hudson is 492 kilometres long and rises in a lake called Tear-of-the-Clouds, 1,317 metres above sea level in the Adirondack Mountains. The Hudson flows south near the eastern boundary of New York and empties into the Atlantic Ocean at New York City.

In its upper course, the Hudson has many rapids, and the cities along its banks make use of the current for water power. Farther south, the Hudson enters the colourful Highlands region. Here it winds for 26 kilometres through a narrow valley with high, rocky shores of great beauty. The rocks in this area look like the castles on the banks of the Rhine. Huge rock cliffs that are called the *Palisades* lie to the south of the Highlands. The Mohawk River joins the Hudson just north of the city of Troy. South of this junction, the Hudson receives much water from the tides of the Atlantic Ocean.

Large ships can sail up the Hudson to Albany, which is 232 kilometres from the mouth of the river. Small boats can continue to Troy, 10 kilometres beyond Albany. Travellers from Europe come ashore at the huge docks in New York City on the east bank of the mouth of

The Hudson River at Bear Mountain bridge runs through a wooded area of the Highlands region, in New York, U.S.A.

the Hudson. The George Washington Bridge spans the river near its mouth.

In 1524, the Italian sailor Giovanni da Verrazano became the first European to reach the river. The Dutch were the first Europeans to settle in the Hudson River Valley. The excellent harbour at the mouth of the Hudson determined the site of New York City. Many early explorers travelled up the Hudson on their way to Canada.

During the American Revolution, (1775-1783) a huge chain was hung across the river between Constitution Island and Gee's Point to keep the British ships from passing. Robert Fulton ran the first successful steamboat on the Hudson in 1807.

See also **Fulton, Robert; George Washington Bridge; Hudson, Henry.**

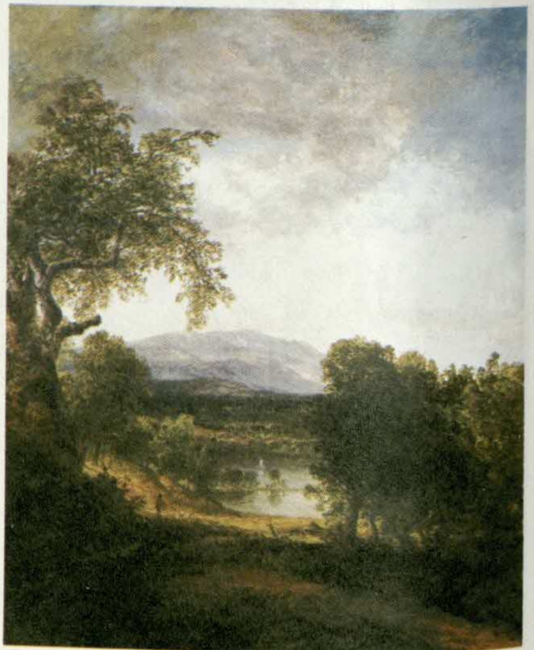
Hudson River School was the name of the first group of American artists to develop a characteristic style of landscape painting. The school flourished from 1825 until the late 1800's. The early artists of this group painted many scenes of the Hudson River Valley in New York. Later artists of the school painted landscapes of various areas of North and South America.

Before the 1800's, there was almost no tradition of landscape painting in America. Some Hudson River School paintings resembled the peaceful countrysides painted by many Europeans. But others showed the untamed beauty and the grandeur of canyons, rivers, and other natural features. These landscapes reflected the artists' pride in their country and their love of nature.

The Hudson River School first became known in 1825. That year, the landscapes of Thomas Cole gained popularity. The originality and directness of Cole's works impressed many artists, and he became a leader of the Hudson River group. Other artists who helped the school develop included Thomas Doughty and Asher B. Durand. Later artists included Albert Bierstadt, Frederick E. Church, Jasper F. Cropsey, John F. Kensett, and Thomas Moran.

See also **Bierstadt, Albert; Church, Frederick E.; Cole, Thomas; Painting** (The 1800's [United States painting]).

Hudson's Bay Company is a business firm that became famous for its role in western Canadian history. It was founded in London in 1670 to establish a fur trade in what is now the Hudson Bay region. Today, it ranks as one of Canada's largest corporations.



Oil painting on canvas (about 1840); the Metropolitan Museum of Art, New York

The Hudson River School was a group of American landscape painters. Thomas Doughty, a leader of the school, painted *A River Glimpse, above,* which shows the Hudson River Valley.

The Hudson's Bay Company contributed to Canada's settlement. This trading post in Ontario was photographed in 1886.

Beginnings. A group of English merchants and noblemen founded the Hudson's Bay Company with the help of two French fur traders, Sieur des Groseilliers and Pierre Esprit Radisson. The two traders knew that furs from North America could earn fortunes. After a quarrel with the French colonial government in Quebec over profits and taxes, they had offered their services to Charles II of England.

In 1668, Groseilliers helped direct a trading expedition to the Hudson Bay region. The expedition was so successful that the king gave the Hudson's Bay Company a charter in 1670. The firm received sole trading rights in all lands drained by the streams that flowed into Hudson Bay. Company agents built trading posts and forts along the bay. They traded with the Indians and exchanged such goods as guns, kettles, and knives for beaver pelts. In England, the pelts were made into expensive felt for garments and hats.

Growth and problems. For many years, the company struggled with the French, who also claimed the Hudson Bay region. French forces from Montreal and Quebec captured and destroyed many of the firm's trading posts. In addition, French fur traders began to threaten the company's trade monopoly with the Indians. But the British conquered Canada in 1763, and the company gained almost complete control of the fur trade in the region.

During the late 1770's and 1780's, the North West Company, a newly organized group of independent fur traders, began competing with the Hudson's Bay Company. Because of the growing competition, the Hudson's Bay Company sent expeditions far inland to find new sources of fur. Its explorers established a network of trading posts and transport routes. The Hudson's Bay Company thus helped open Canada to settlement all the way to the Pacific coast.

In 1821, the two rival companies combined under the name Hudson's Bay Company. This company was completely reorganized under the leadership of Sir George Simpson (see **Simpson, Sir George**). It held full land and trading rights in much of western British North America until 1870. That year, the company gave the British government much of the territory granted by its charter. The government, in turn, transferred the land to the newly formed Dominion of Canada. The company received about £300,000 for the land from the Canadian government. It lost certain trading rights but kept large areas of the western plains. The Hudson's Bay Company later sold these lands to settlers.

Recent developments. Today, the Hudson's Bay Company ranks as the world's largest fur-trading firm. But its main business is the retail trade. The company owns a chain of department stores in Canada. It also operates a large wholesale enterprise that distributes a variety of merchandise to stores throughout Canada and the United States.

See also **Radisson, Pierre E.**

Hue (pop. 209,043) is a city in central Vietnam. For the location of Hue, see **Vietnam** (map). Sand dunes and shallow lagoons cut off Hue from the South China Sea. However, the land behind the dunes is flat and cultivated. The city is a centre of student and religious life. The University of Hue was founded there in 1957.

Hue was the capital of Vietnam during the rule of the Nguyen dynasty in the 1800's. It continued as the royal capital until 1945.

Hue became part of South Vietnam when that nation was formed in 1954. Communist forces seized Hue in 1968 in one of the largest attacks on South Vietnam of the Vietnam War. South Vietnamese and United States troops together recaptured Hue less than a month later.

Hue and the rest of South Vietnam came under the control of Communist North Vietnam in 1975. The Communists unified North and South Vietnam into the single nation of Vietnam in 1976.

Hue. See **Colour** (Characteristics of colour).

Huemul. See **Deer** (Central and South American).

Hugh Capet (940?-996) was king of France from 987 to 996. Three of his ancestors had been French kings during the 800's and 900's. Kings descended from Hugh ruled France without interruption from 996 until 1792, and again from 1814 to 1848. A line of French kings related to Hugh took its name from him and became known as the Capetian dynasty. This dynasty replaced the Carolingian family of French kings, who were descended from the great French ruler Charlemagne. See **Capetian dynasty.**

Hugh was head of an important family in northern France. The leading princes of France elected him king in 987. As king, Hugh had little power outside his ancestral lands. But in 987 he arranged to have his son Robert elected *king-designate,* or the king's successor. The next several kings designated their heirs in a similar way, and the French monarchy eventually became hereditary.

See also **Bourbon; Valois.**

Hugh of Lincoln, Saint (1135?-1200), was bishop of Lincoln from 1186 until his death. He won the admiration of Henry II and of Richard I by fearlessly arguing against them. He reformed the see, quelled riots against the Jews, and championed the people against unjust royal foresters.

Hugh was born at Avalon, in Burgundy, France, and became a Carthusian monk. Henry II summoned him to England in 1175 to take charge of the Carthusian monastery at Witham, in Somerset. Hugh was canonized in 1220.

Hughes, Howard Robard (1905-1976), an American businessman, became known as one of the world's richest people. During the 1930's and 1940's, he achieved fame as a film producer and aviator. Then, in the mid-1950's, Hughes deliberately dropped out of sight. He became a mysterious figure who never appeared in public. Hughes even refused to have his photograph taken.

Howard Hughes

Hughes was born in Houston, Texas. His father died in 1924, leaving him the Hughes Tool Company, an oil-field equipment firm. The firm became the basis of Hughes's financial empire. He later owned the Hughes Aircraft Company, RKO Pictures Corporation, and a controlling interest in Trans World Airlines.

Hughes led a varied life. He became a Hollywood film producer after his father's death. His most successful movies included *Hell's Angels* (1930), *Scarface* (1932), and *The Outlaw* (1943). Hughes also designed and raced aeroplanes. He set several speed records, including an around-the-world mark of 3 days 19 hours 14 minutes. In the 1940's, he designed the plane that still holds the record for the largest wingspan of any plane ever built—97.57 metres. This eight-engine wooden flying boat, nicknamed *Spruce Goose,* had room for 700 passengers. In 1947, Hughes piloted the plane on its only flight. It flew 1.6 kilometres at a height of 21 metres. Today, the *Spruce Goose* is on display in Long Beach, California.

At the time of Hughes's death, estimates of the value of his estate were as high as 2 billion U.S. dollars. But in 1984, the United States Internal Revenue Service and the states of California and Texas valued the estate at $380 million for taxation purposes. California and Texas worked out an agreement to share the inheritance taxes from the Hughes estate.

In 1971, the McGraw-Hill Book Company paid about 750,000 U.S. dollars to Clifford Irving, a writer, for a manuscript he presented as Hughes's autobiography. Irving claimed he worked on it with Hughes, but Hughes denied knowing Irving. In 1972, Irving and his wife admitted to misrepresenting the manuscript to the publisher. They were fined and imprisoned.

Hughes, Langston (1902-1967), was a black American author. He published works in all forms of literature, but he was best known for his poetry and his sketches about a black man called "Simple."

Most of Hughes's sketches about Simple have no plot. Simple expresses his opinions about current issues. He is outspoken, emotional, and impulsive. Hughes used Simple to indicate what an intelligent, but uneducated, proud black man might say if given the chance.

In his best-known poetry, Hughes wrote proudly and optimistically about black people. He experimented with poetic *metre* (rhythm), using the rhythms of black music in his poetry. The literary respect he earned probably influenced the metrical experiments of other black American poets during the 1960's. Hughes was also highly interested in drama. He wrote plays and established theatrical companies. His drama *Mulatto* (1935) had a long run of 373 performances on Broadway.

Hughes wrote or edited more than 50 books. Examples of his work are *Not Without Laughter* (1930), a novel; *The Ways of White Folks* (1934), a collection of short stories; *The Big Sea* (1940), an autobiography; *The Langston Hughes Reader* (1958); *The Selected Poems of Langston Hughes* (1959); *The Best of Simple* (1961); and *Five Plays by Langston Hughes* (1963). James Langston Hughes was born in Joplin, Missouri. He graduated from Lincoln University in Pennsylvania.

Hughes, Ted (1930-), is an English poet known for his violent and symbolic nature poems. Hughes was appointed poet laureate of Britain in 1984.

Hughes's first collection of poetry, *The Hawk in the Rain* (1957), portrays in powerful and descriptive language the beauty and brutality he saw in nature. Hughes's reputation increased after he published a long cycle of lyrics dominated by a menacing bird called Crow. The bird is a composite symbol taken from several mythical and religious traditions. The Crow poems were published in five volumes in 1970 and 1971. The best-known work in the cycle is *Crow: From the Life and Songs of the Crow* (1970). Hughes continued his mythical themes in *Cave Birds* (1975). Hughes's later nature poems, beginning with *Moortown* (1980), carry a note of hope and affirmation absent from his previous work.

Edward James Hughes was born in Mytholmroyd in West Yorkshire. The birds and other animals Hughes observed on the moors near his home strongly influenced the content and imagery of his poetry. Hughes was married to the American poet Sylvia Plath from 1956 until her suicide in 1963.

Hughes, Thomas (1822-1896), was an English author. He is best known for his novel *Tom Brown's School Days* (1857), the earliest story about life in a British public school. Hughes based the book on his experiences at Rugby School (see **Rugby School**). His next novel, *Tom Brown at Oxford* (1861), was less successful. He then devoted himself to religious and political writing.

Hughes was born in Berkshire and attended Oxford University. He became a lawyer and served in Parliament. He was active in the Christian Socialist movement and worked to improve conditions among the poor. Hughes sponsored a short-lived settlement for poor English boys in Rugby, Tennessee, U.S.A.

Hughes, William Morris (1862-1952), served as prime minister of Australia from 1915 to 1923. He was one of the most remarkable political figures in Australian history. He was elected to the first Australian federal Parliament in 1901 and served continuously as a parliamentarian until his death in 1952. He was prime minister of Australia for three of the four years of World War I. On Australia's behalf, he travelled to England in 1916. There he was widely acclaimed by the British public for his plain speaking and for his fiery and patriotic speeches. Hughes was made a member of the Imperial War Cabinet from 1916 to 1919.

Early life. Billy Hughes was born in London on Sept. 25, 1862. His parents had moved there from Wales. His father was a carpenter. His mother was a farmer's daughter who had entered domestic service. His mother died when he was four years old and he was brought up by an aunt, Mary Hughes.

In 1884, Billy Hughes emigrated to Australia. He arrived in Brisbane, but found work hard to obtain in the city. He moved about Queensland and New South Wales doing a variety of jobs. He worked as a drover, a blacksmith's striker, and a seaman.

Member of Parliament. Hughes first became associated with the Labor movement after he had settled in Sydney, where he opened a shop at Balmain. Hughes became active in organizing the Wharf Labourers' Union and became its first secretary. In 1894, he was elected to the New South Wales parliament. He was elected to the federal Parliament at the first election in 1901. He studied law and was admitted to the bar in 1903.

Until 1909, the Labor Party held the balance of power in the federal Parliament, and for two periods, held office itself. Hughes first became a minister in the federal Parliament in 1904, when Chris Watson formed a ministry and became Australia's first Labor prime minister. In 1908, Hughes became attorney general in the government of Andrew Fisher. He held that post again from 1910 to 1913.

Prime minister. In October 1915, Andrew Fisher resigned as prime minister and was replaced by Hughes. Hughes believed the war against Germany should be prosecuted to the fullest extent. By 1916, the losses suffered by the Allied forces were already so immense that the system of voluntary recruiting was not adequate to keep up supplies of men. Hughes believed that conscription of all able-bodied men without dependants should be introduced to meet the demand. But he knew that this measure was widely opposed within the Labor Party. In November 1916, the issue came to a head within the parliamentary Labor Party. Hughes and 24 supporters broke away from the party and formed a government dependent on the Liberal Party. Hughes' supporters and the Liberal Party formed a new party called the *Nationalist Party,* which won the general election in 1917.

In June 1918, Hughes visited England again. Germany surrendered in November 1918, and Hughes became a delegate to the Peace Conference in 1919. He secured the separate representation of Australia, New Zealand, South Africa, and Canada at that conference. He also secured their recognition as separate political entities at the League of Nations, which was then being formed. Hughes had little faith in the plans of President Wilson of the United States or in the usefulness of the League of Nations as a peacekeeper. He wanted a tough policy toward Germany. Hughes returned to Australia in August 1919. He was still popular with the Australian public, and the Nationalist Party, under his leadership, was returned to office in 1919. In 1922 Hughes was replaced as prime minister by Stanley Bruce. In 1931, he joined Joseph Lyons' newly formed United Australia Party. He remained in Parliament until his death.

Hugo, Victor Marie (1802-1885), a French author, led the romantic movement in French literature. His writings reveal his love of liberty, his sense of justice, and his sympathy with the suffering of ordinary people. Hugo's *The Hunchback of Notre Dame* and *Les Misérables* rank among the most popular fiction written.

Early life. Hugo was born in Besançon, the son of an officer in the army of Napoleon I. He spent his first 10 years in Corsica, Italy, and Spain, where his father was stationed. Hugo's experiences in those places influenced both him and his writings.

In 1822, Hugo married his childhood sweetheart, Adèle Foucher. About this time, he decided to be a writer. In the preface to his play *Cromwell* (1827), Hugo demanded freedom for dramatists from the rigid literary rules that governed playwriting. This preface became the principal declaration of French romanticism. Many scholars consider Hugo's verse drama *Hernani* (1830) the beginning of the romantic movement in France because of its deliberate break with dramatic conventions.

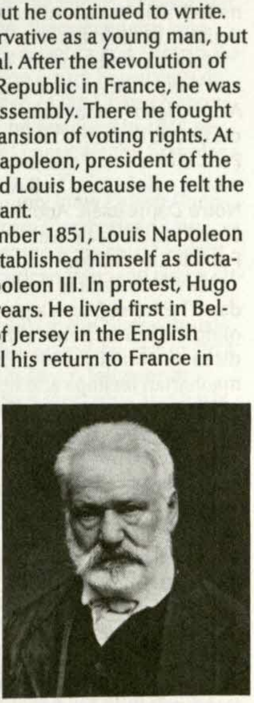
Hugo wrote poetry and fiction during the same period that he wrote plays. He published a series of successful books of poetry, including *The Orientals* (1829), *Leaves of Autumn* (1831), *Songs of Twilight* (1835), and *Rays and Shadows* (1840). His best-known novel during this period was *The Hunchback of Notre Dame* (1831).

Political activity. In 1843, Hugo's play *The Burgraves* failed dismally. That same year, his eldest daughter, whom he idolized, drowned with her husband. These events, combined with Hugo's growing interest in politics, lessened his concern with literature. He published nothing for almost 10 years, but he continued to write.

Hugo was a political conservative as a young man, but he became increasingly liberal. After the Revolution of 1848 established the Second Republic in France, he was elected to the new National Assembly. There he fought for free education and an expansion of voting rights. At first, Hugo supported Louis Napoleon, president of the republic. But he soon opposed Louis because he felt the president was becoming a tyrant.

Exile and return. In December 1851, Louis Napoleon overthrew the republic. He established himself as dictator with the title Emperor Napoleon III. In protest, Hugo went into exile for almost 20 years. He lived first in Belgium and then on the island of Jersey in the English Channel. Then, from 1855 until his return to France in 1870, he lived on the channel island of Guernsey. In 1853, Hugo published *The Chastisements,* a collection of satirical poems that denounced Napoleon III for destroying the Second Republic. In 1859, Hugo rejected a government invitation to return to France. He declared that he would return only with the return of liberty.

During his exile, Hugo published many of his fin-



Victor Hugo

est works. *The Contemplations* (1856) contains his best lyric poetry. These poems reveal the strong influence of Hugo's memories of his dead daughter and of his love for her. *The Legend of the Centuries* (1859, new sections added in 1877 and 1883) is Hugo's masterpiece in epic poetry. *Les Misérables* appeared in 1862.

Hugo became a symbol of freedom to Frenchmen during his years of exile. After the overthrow of Napoleon III in 1870 during the Franco-Prussian War, Hugo returned to France in triumph. He spent his final years honoured by his fellow citizens as the champion of democracy and of the common people.

His works. Hugo wrote an enormous number of works during a career of more than 60 years. During his lifetime, he gained his greatest popularity for his plays. In Great Britain and the United States, he became known chiefly as a novelist. The French today consider him a giant of literature for his poetry.

Throughout his life, Hugo composed epic, lyric, and satirical poetry. He often combined these types into individual collections or even single poems. Hugo's finest poetry appeared after 1850. He wrote *The Chastisements* in a wide variety of poetic forms, including elegies, fragments of epics, odes, and songs. *The Contemplations* expresses many of Hugo's philosophical and religious beliefs. These include his strong faith in God and his belief in immortality and the soul. *The Legend of the Centuries* traces humanity's historical and spiritual development from the Creation to the 1900's. At the end of this work, Hugo predicted that humanity faced a destiny of continual material and moral progress.

In his plays, Hugo used many devices of melodrama, including complicated and unrealistic plots, exaggerated emotions, and a flowery style. The plays rise above melodrama in their moral or political message and particularly in their superior use of poetry.

Hugo's novels endure because of their moral lessons and their vivid re-creations of history. *The Hunchback of Notre Dame* established Hugo as a master of the historical novel. The story takes place during the 1400's in Paris. The central characters of the novel are Quasimodo, a deformed bell ringer, and the Cathedral of Notre Dame itself. Another historical novel, *Ninety-Three* (1874), deals with events that took place in the French Revolution.

Les Misérables is a novel set in the France of Hugo's day. The hero, Jean Valjean, is an escaped convict struggling to lead an honest, useful life despite the prejudices of a cruel society. This novel expresses Hugo's humanitarian feelings and his belief in democracy.

Hugo's reputation as a writer declined after his death. Many critics said that his ideas were shallow and his style often wordy and overly sentimental. Today, Hugo's works have found renewed interest because of his imaginative treatment of his subjects and his skilful use of literary forms.

Huguenots were a group of Protestants who became the centre of political and religious quarrels in France in the 1500's and 1600's. They believed the teachings of John Calvin and belonged to the Reformed Church. The French Roman Catholics named them *Huguenots.* The name may have come from that of Besançon Hugues, a Swiss religious leader.

Detail of *Massacre of the Huguenots,* an oil painting by François Dubois (late 1500's); Musée Cantonal des Beaux-Arts, Lausanne, Switzerland

A massacre of Huguenots by pro-Catholic forces began in Paris on Saint Bartholomew's Day in 1572. The massacre spread through France and thousands of Huguenots were murdered.

During the reign of Henry II (1547-1559), the Huguenots became a large and influential political group in France. As they grew strong, the Catholic government persecuted them more and more. Such important people as Anthony, King of Navarre; Louis I de Bourbon de Condé; and Admiral Gaspard de Coligny were Huguenots. The Guise family led the Catholic group. The Guises influenced Henry's son, King Francis II, against the Huguenots.

The massacre. After Francis II died and Charles IX became king, the queen mother, Catherine de Médicis, controlled France. For a time, she encouraged the Huguenots as a balance against the Guises. But feelings in both parties became so bitter that civil war broke out. Catherine feared that Coligny was influencing her son too much, so she allied herself with the Duke of Guise. Beginning on Aug. 24, 1572, they carried out the Massacre of Saint Bartholomew's Day. During the next several days, thousands of Huguenots were murdered.

But the political pendulum swung again in the other direction. Henry III feared the popularity of the Guise family and had the Duke of Guise and his brother, the cardinal, assassinated. These murders aroused public feeling against Henry, and he allied himself with Henry of Navarre and the Huguenots. However, Henry III was assassinated, and Henry of Navarre became the new king in 1589.

Most of France was Catholic, and Henry decided he must become a Catholic to be a successful king. But he remembered the Huguenots and in 1598 issued the Edict of Nantes. This law gave the Huguenots freedom of worship in 100 communities. The edict also gave them political freedom. The Huguenots thus formed a sort of Protestant republic within the Catholic kingdom.

Flight from France. The Huguenots lost their political freedom during the reign of Louis XIII. His minister, Cardinal Richelieu, conquered their cities. But they were still allowed freedom of worship. They did not lose this until 1685, when Louis XIV repealed the Edict of Nantes. Thousands of Huguenots fled France to new homes in England, Prussia, the Netherlands, and America. Many settled and prospered in South Carolina, Virginia, Massachusetts, and New York.

Some of the laws against the Huguenots were relaxed shortly before the French Revolution began in 1789. But Huguenots did not get religious and political freedom until the Constituent Assembly (1789-1791) gave equal rights to Roman Catholics, Protestants, and Jews.

Most of the Huguenots were craftworkers or textile workers. They played a large part in building up the English textile industry.

Related articles in *World Book* include:

Catherine de Médicis
Charles (IX) of France
Henry (III, IV) of France
Nantes, Edict of
Richelieu, Cardinal
Saint Bartholomew's Day, Massacre of

Huhu beetles, the largest beetles found in New Zealand, are common throughout the country. They are brown insects, up to 50 millimetres long. They can nip people who handle them, but are generally harmless. The grub stage lives in timber and does considerable damage to posts and dead trees. The Maoris ate the grubs and considered them a delicacy.

Scientific classification. Huhu beetles are classified as *Prionoplus reticularis.*

Hui-tsung. See **Huizong.**

Huias were birds, now extinct, that used to live in New Zealand. They were about 45 centimetres long. The females had long, curved bills, and the males had shorter, straight ones. They had glossy, black plumage and pink flesh at the corner of their bills. European hunters and predators killed them off.

Scientific classification. Huias belonged to the family Callaeatidae.

Huizinga, Johan (1872-1945), was a noted Dutch historian. He was especially interested in portraying the spirit of an entire age or civilization. His fame rests on the range and quality of his writings, and his ability to capture the very flavour of life. Huizinga's most famous work, *The Waning of the Middle Ages* (1919), is a study of life in the Netherlands during the 1300's and 1400's.

Huizinga was born in Groningen, the Netherlands, and studied at the University of Groningen. His major works include *In the Shadow of Tomorrow* (1935), a collection of essays on the cultural condition of people in modern society; and *Homo Ludens* (1938), a study of human culture as seen in play. Huizinga was jailed by Nazis during World War II, and died in February 1945, shortly after his release.

Huizong (reigned A.D. 1101-1126), also spelled *Hui-tsung,* the last emperor of the Northern Song dynasty of China, was the greatest imperial patron of art. A painter himself, he specialized in colourful, realistic bird and flower subjects. Huizong tried to keep court art at a high level of quality by supervising the training of candidates at the Imperial Academy. Huizong's art interests made him a careless and feeble ruler, and he was overthrown by the Tartars.

Hukbalahap, also called *Huk,* a Communist guerrilla movement, tried to overthrow the democratic government of the Philippines from 1945 to 1954. Its full name was *Hukbong Magpapalayang Bayan* (People's Liberation Army). The Huk movement failed because the Philippine government offered the people fair play and land reform, helped the Huks resettle on Mindanao Island, and defeated Communist guerrillas. Ramón Magsaysay, hero of the fight against the Huks, became president of the Philippines in 1953 and served until his death in 1957.

Hull (pop. 252,200) is a large industrial city and one of Britain's leading industrial ports. Its official name is Kingston upon Hull. It is a local government district in the county of Humberside. Hull's port facilities include container docks, fish docks, and ferry docks. Daily ferries sail from Hull to Rotterdam and Zeebrugge in the Netherlands. Hull has a great variety of manufacturing industry. Its important products include cement, chemicals, and paper.

In 1243, Edward I acquired the trading settlement of Wyke at the junction of the Hull and Humber rivers. Edward renamed the town Kingston upon Hull. It was used specifically as a port for northeastern England. The port now extends about 11 kilometres along the north bank of the Humber estuary. Hull University was founded as University College, Hull, in 1927.

See also **Humberside.**

Hull, Cordell (1871-1955), an American statesman, won the 1945 Nobel Peace Prize for his peace efforts while serving as U.S. secretary of state from 1933 to 1944. One of his greatest achievements was making the good-neighbour policy between the United States and Latin-American countries effective. He worked out the trade treaties that brought almost complete solidarity among all the American nations.

Hull also tried to avoid war in the Pacific. When Pearl Harbor was attacked in 1941, he denounced the Japanese ambassadors, Kichisaburo Nomura and Saburo Kurusu, for Japan's deceit. A leading figure in wartime diplomacy, Hull conceived the idea of the United Nations organization for peace. Before he resigned in 1944 because of poor health, he helped complete the first plans for the United Nations.

Hull was born in Overton County (now Pickett County), Tennessee. He graduated from Cumberland Law School. He served in the Tennessee legislature, fought as a captain in the Spanish-American War, and was a circuit court judge in Tennessee.

In 1907, Hull was elected to the United States House of Representatives. He wrote the income-tax law in 1913, and also the 1916 inheritance-tax law. A follower of Woodrow Wilson, Hull supported low tariffs as a basis for international economic cooperation.

Hull served as chairman of the Democratic National Committee in the 1920's. He was elected to the United States Senate in 1930. At the 1932 Democratic National Convention, he helped gain the presidential nomination for Franklin D. Roosevelt.

Hulme, Keri (1947-), a New Zealand writer, won the Booker McConnell Prize, for her novel *The Bone People* in 1985. She was born in Christchurch, New Zealand. In 1972, after several years of working in such varied occupations as woollen mill worker, fish and chip cook, and postwoman, she became a full-time writer. She settled in Okarito, a tiny coastal settlement on the West Coast of the South Island. Hulme spent 12 years in Okarito catching whitebait and writing *The Bone People.*

Human being has the most highly developed brain of any animal. The human brain gives people many special abilities, the most outstanding of which is the ability to speak. Language has enabled human beings to develop *culture,* which consists of ways of behaving and thinking. These ways are passed on from generation to generation through learning. Culture also includes *technology*—that is, the tools and techniques invented by people to help satisfy their needs and desires. The richness and complexity of human culture distinguish human beings from all other animals.

The human brain helps make people the most adaptable of all creatures. They behave with the most flexibility and in the greatest variety of ways. The human body is highly adaptable because it has few specialized features that could limit its activities. In contrast, a seal has a body streamlined for swimming, but it has difficulty moving about on land. People cannot swim as well as a seal, but they can also walk, run, and climb. Human adaptability enables people to live in an extremely wide variety of environments—from the tropics to the Arctic.

People are inquisitive and have long sought to understand themselves and their place in the world. Throughout much of human existence, religion has helped provide such understanding. All societies have assumed that one or more gods influence their lives and are responsible for their existence. Since ancient times, *philosophy* (the study of truth and knowledge) has also provided definitions of what it means to be human.

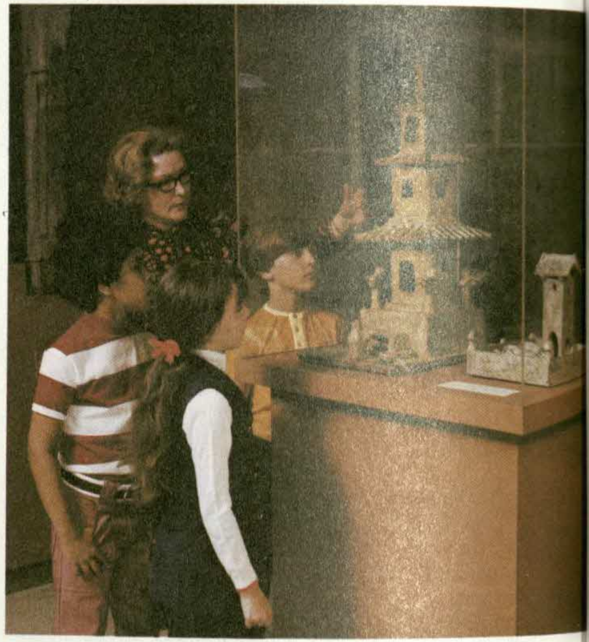
Today, religion and philosophy remain important parts of people's efforts to understand the nature of human existence. But many other fields of study also help human beings learn about themselves. For example, *anthropology* is the study of human cultures and of human physical and cultural development. *Linguistics* is the scientific study of language. Specialists in *psychology* study human and animal behaviour and mental processes. *Sociology* deals with the groups and institutions that make up human societies, and *history* is the study of past human events. Each of these fields has a separate article in *World Book.*

This article describes the physical and cultural characteristics that distinguish human beings from other animals. It also traces human physical and cultural development. For more information on the life of early human beings, see **Prehistoric people.**

Characteristics of human beings

Scientific classification. Biologists classify all living things in groups, including *class, order, family, genus,* and *species.* Human beings belong to the class of animals called *mammals.* There are about 4,000 species of mammals, including such animals as cats, dogs, elephants, and otters. All mammals have a backbone, hair, four limbs, and a constant body temperature. Female mammals are the only animals with special glands that produce milk for feeding their young.

Human beings, along with apes, monkeys, lemurs, and tarsiers, make up the order of mammals called *primates.* Scientists classify human beings and apes in the superfamily *Hominoidea.* The family *Hominidae* consists of human beings and their closest prehuman ancestors.



Human beings, unlike any other creatures, use art and language to preserve a knowledge of history. The museum guide above is describing ancient Chinese buildings and ways of life.

Human beings are the only living members of a genus called *Homo,* the Latin word for *human being.* This genus consists of one living species—*Homo sapiens*—and several extinct human species that are known only through fossil remains. The Latin words *Homo sapiens* mean *wise human being.* All existing peoples belong to the subspecies *Homo sapiens sapiens.*

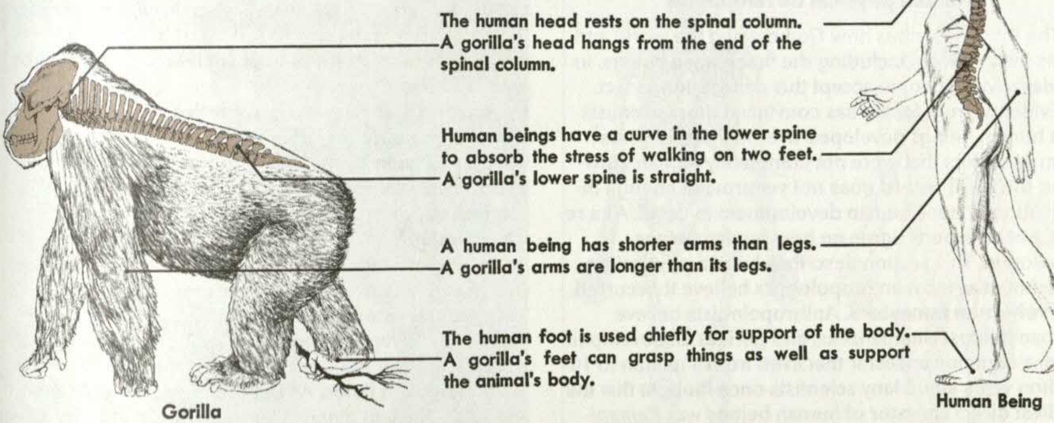
Physical characteristics. Human beings and the other primates share many physical features. For example, both human beings and apes rely on their excellent vision for much of their information about the environment. They have large eyes, sensitive retinas, and *stereoscopic vision* (the ability to perceive depth). Human beings and apes also have a highly developed nervous system and a large brain. Human beings and many other primates have long, flexible fingers and *opposable thumbs,* which can be placed opposite the fingers for grasping. In addition, their fingers and toes have nails instead of claws.

Many of the physical characteristics that distinguish human beings from other primates are related to the ability of people to stand upright and walk on two legs. This ability chiefly requires long, powerful legs. The human rump has strong muscles that propel the body forward and balance the trunk alternately on each leg when a person walks. In contrast, apes spend most of their time climbing and swinging in trees or walking on all four limbs. Their rumps have relatively weak muscles, and their arms are longer and stronger than their legs.

The human spine, unlike the spine of any other animal, has a curve in the lower back. This curve helps make upright posture possible by placing the body's centre of gravity directly over the pelvis. The human foot is also specially adapted for walking on two legs. Apes

Physical differences between human beings and apes

The bodies of human beings are suited to walking on two feet. On the other hand, the bodies of apes are suited to walking on four limbs or climbing. Some of the resulting physical differences between people and apes are shown below.


The human head rests on the spinal column. A gorilla's head hangs from the end of the spinal column.
Human beings have a curve in the lower spine to absorb the stress of walking on two feet. A gorilla's lower spine is straight.
A human being has shorter arms than legs. A gorilla's arms are longer than its legs.
The human foot is used chiefly for support of the body. A gorilla's feet can grasp things as well as support the animal's body.
Gorilla
Human Being

use all four limbs to support their weight, and they can grasp objects almost as well with their feet as with their hands. In human beings, however, the feet support the entire weight of the body, and the toes have little ability to grasp or to move independently.

The human brain is extremely well developed and at least twice as large as any ape's brain. Because of the brain's size, the human skull is rounder than any other primate's skull.

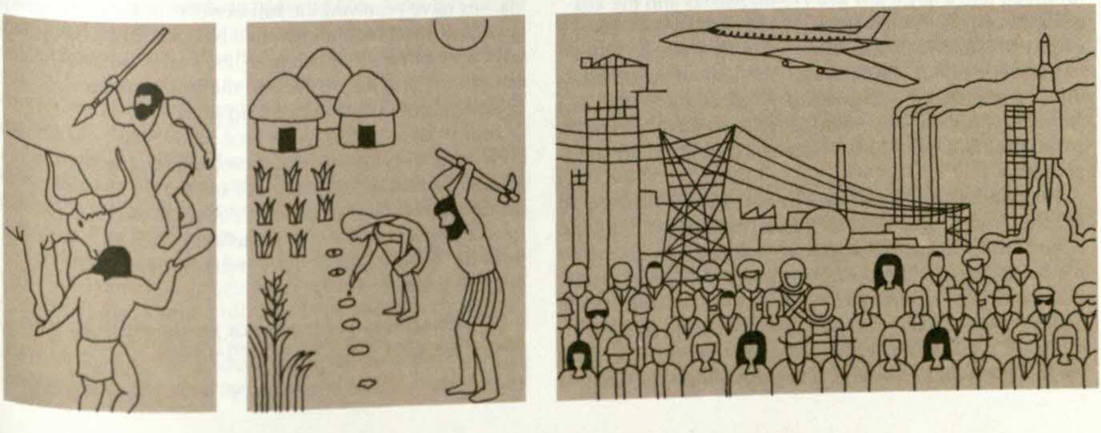
Human beings live longer and develop more slowly than other primates. The human life span varies from an average of about 40 years in many developing countries to more than 70 years in most industrial nations. A human infant is born completely helpless and depends on its parents for many years. Most human beings reach full maturity only between 18 and 25 years of age. Slow growth and development allow for a much longer period of learning and brain growth than exists in any other species.

Cultural characteristics. Some animals have simple aspects of culture. For example, young chimpanzees learn from older members of their group how to make some tools. They catch termites by peeling a twig and inserting it into a termite mound. They also chew leaves to make sponges for soaking up water to drink.

Certain animals, including apes and monkeys, communicate by making a wide variety of sounds. These sounds express emotion and may communicate simple messages, but they apparently do not symbolize any object or idea. Language distinguishes human culture from all forms of animal culture. Through elaborate use of symbols, language enables people to express complex ideas and to communicate about objects and events that are distant in time and place. By using language, human

Human cultural development

Human cultural development can be divided into three phases. The earliest societies, *left,* hunted wild animals and gathered wild plants for food. Agricultural societies, *centre,* controlled their food sources by farming. Industrial societies, *right,* use advanced technology, resulting in both major achievements and complex problems.



beings have developed the ability to reason and to solve problems on a far higher level than any other animal. Language also enables human beings to pass on knowledge and skills from generation to generation.

Human physical development

The Bible describes how God created the world and all its living things, including the first human beings, in six days. Many people accept this description as fact.

Evidence from fossils has convinced most scientists that human beings developed over millions of years from ancestors that were not completely human. However, the fossil record does not yet provide enough information to trace human development in detail. As a result, not all experts agree on how human beings developed. This section describes human physical development as most anthropologists believe it occurred.

Prehuman ancestors. Anthropologists believe human beings, chimpanzees, and gorillas all developed from a common ancestor that lived from 4 million to 10 million years ago. Many scientists once thought that the earliest direct ancestor of human beings was *Ramapithecus,* which lived from 8 million to 14 million years ago. During the 1970's and early 1980's, however, discoveries of *Ramapithecus* fossils suggested that the creature was an ancestor of the orangutan, a kind of ape.

More than 4 million years ago, a humanlike creature called *Australopithecus* appeared in Africa. Fossil remains of the australopithecine skeleton indicate that these creatures stood fully erect and walked on two legs. The australopithecines were about 120 to 150 centimetres tall and had a brain about a third the size of a modern human brain.

Early human beings. Most scientists regard the species *Homo habilis* (skilful human being) as the first type of human being. These primitive people appeared about 2 million years ago in Africa and are believed to have developed from the australopithecines. Archaeological evidence shows that *Homo habilis* used stone tools. *Homo habilis* fossils have been found at Lake Turkana, Kenya, and other areas in eastern Africa.

Most scientists believe that *Homo habilis* developed into a more advanced type of prehistoric human being known as *Homo erectus* (erect human being). *Homo erectus* appeared about $1\frac{1}{2}$ million years ago in Africa and spread to Asia and Europe. It had a larger brain than its ancestors. From the neck down, *Homo erectus* resembled the human beings of today. But it had a low forehead and a large jaw like *Homo habilis* and the australopithecines. *Homo erectus* made and used a wider variety of stone tools than *Homo habilis.* It learned how to make fire about 500,000 years ago and was probably the first human species to do so. Fossils indicate that *Homo erectus* may have hunted large animals, and this sort of hunting would have required planning and cooperation.

Human beings of today. The first members of the species *Homo sapiens* (wise human being) appeared between about 400,000 and 300,000 years ago. These people basically resembled *Homo erectus* but had a larger brain and smaller jaws and teeth. As time passed, *Homo sapiens* developed a rounded skull and long, straight limbs. *Homo sapiens* looked like today's human beings by at least 40,000 years ago, and perhaps as early as 100,000 years ago. Most anthropologists classify all people who have lived in the last 40,000 years as *Homo sapiens sapiens.*

Human cultural development

Human culture has developed in three major phases. These phases have been based on (1) hunting and gathering societies, (2) agricultural societies, and (3) industrial societies.

Hunting and gathering societies. For almost the entire prehistoric period of human existence, people lived by hunting game and gathering fruit, nuts, roots, seeds, and other plant foods. Archaeological evidence suggests that the hunters and gatherers lived in widely separated groups of 25 to 50 people. These primitive people wandered over large areas in search of food. They lived in harmony with their environment and used their natural resources efficiently.

The first inventions probably included weapons and cutting tools for butchering animals, plus containers for gathering plant foods. As people improved their hunting skills, they obtained large amounts of meat by killing huge mammals, including elephants.

Agricultural societies became possible after people began to domesticate wild animals and plants about 9000 B.C. These farming activities greatly increased the amount of food available in any area. Permanent villages started to appear, and then towns and cities developed. The larger and more dependable supply of food supported a continually increasing population.

Agriculture made it unnecessary for everyone to help in the production of food. Some people became specialists in other fields, such as manufacturing or trade. Governments were established and systems of writing were created. Thus, the invention of farming opened the way for the development of civilization.

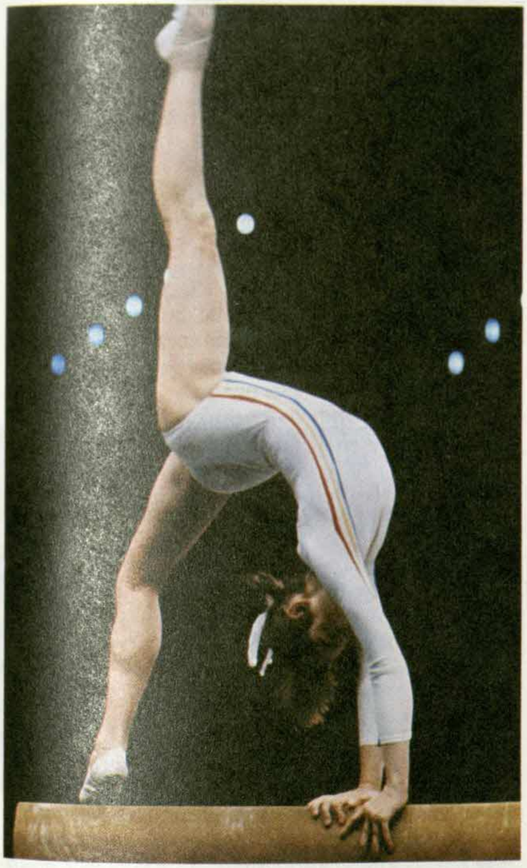
Industrial societies appeared in their modern form during the A.D. 1700's, after people learned to run machinery with energy from coal and other fuels. Today, petroleum, coal, natural gas, and nuclear fuel furnish most of the energy used by industrial societies. These fuels have brought a great expansion of technology.

The processes and products developed by industry have greatly improved the standard of living for countless people. These developments have also helped make possible many other advances, including tremendous increases in human knowledge and in the variety of artistic expression. But not all nations and economic classes have received the full benefits of industrial progress. Industrial technology also has produced many negative side effects. For example, its wastes pollute the environment, and its production methods sometimes create monotonous, unfulfilling jobs.

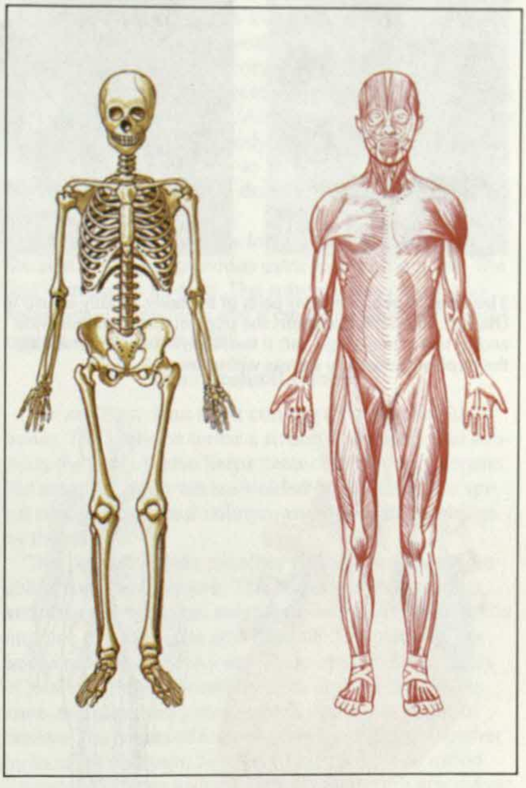
Industrial societies today face many major challenges. New technologies must be developed to use the world's limited natural resources more efficiently. New, nonpolluting sources of energy are needed. In addition, people must find ways to control population growth and to extend the benefits of modern technology to all the world's people.

Related articles. See **Prehistoric people** and its list of *Related articles.* See also the following articles:

Ape
Civilization
Culture
Human body
Primate
Races, Human



The human body can perform amazing acts of strength and grace. A highly trained athlete can push the body to the limits of its powers.



The skeletal system includes more than 200 bones and makes up about 18 per cent of the body's weight. It provides the body with a sturdy framework. Bone is strong, yet light and flexible.

The muscular system consists of more than 600 muscles and makes up about 40 per cent of the body's weight. Muscles can *contract* (shorten). By contracting, the muscles enable the body to move.

Human body

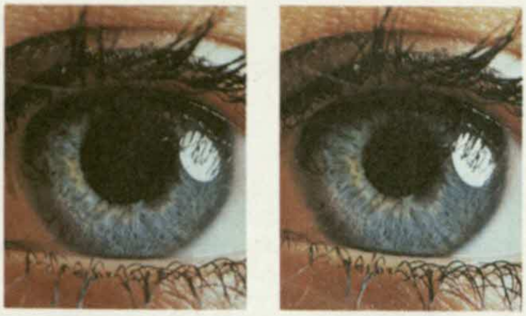
Human body. People sometimes call the human body a machine—the most wonderful one ever built. Of course, the human body is not a machine. But it can be compared to one in many ways. Like a machine, the body is made up of many parts. Each part of the body, like each part of a machine, does special jobs. But all the parts work together and so make the body or the machine run smoothly. Also like a machine, the body needs energy to work. In such a machine as a car, the energy comes from petrol. In the body, it comes from food and oxygen.

Although the human body can be compared to a machine, it is far more amazing than any machine. It can do things that no machine can do. For example, the body can grow. The body starts out as one cell. In time, this tiny cell develops into a body consisting of trillions of cells. The human body can also replace certain worn-out parts. Each day, about 2 billion of the body's cells wear out and are replaced. Thus, the body is always rebuilding itself. Every 15 to 30 days, for instance, the human body replaces the outermost layer of skin.

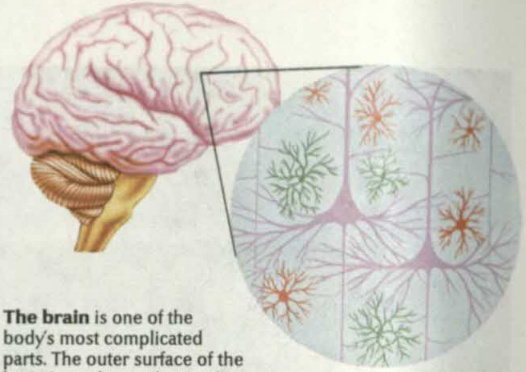
The human body can defend itself against hundreds of diseases. The body can also repair itself after most small injuries. Many body parts, such as the heart and kidneys, work continuously. The heart of a 70-year-old person, for example, has pumped at least 174 million litres of blood during that person's life. In addition, the person's kidneys have removed wastes from more than 3.8 million litres of blood.

By using its senses, the body can detect changes in its surroundings, such as changes in temperature, light, or sounds. It can adjust to these changes immediately. The body's senses are truly incredible. For instance, people can learn to identify thousands of odours, yet smell is one of the least developed senses in human beings. The human body can also detect changes that occur within itself, such as changes in body temperature. The various parts of the body continuously adjust their activities to keep the "inside" environment normal. Such adjustments rely on a system of nerves that carries messages from one part of the body to another. The messages travel at speeds of up to 90 metres per second.

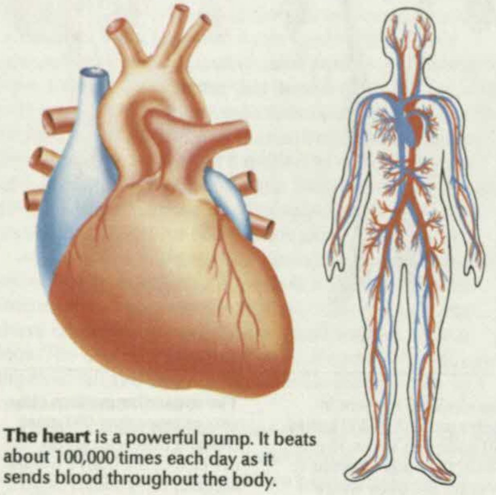
The most remarkable part of the human body is the brain. The human brain is so highly developed that it makes people different from all other living things. Their



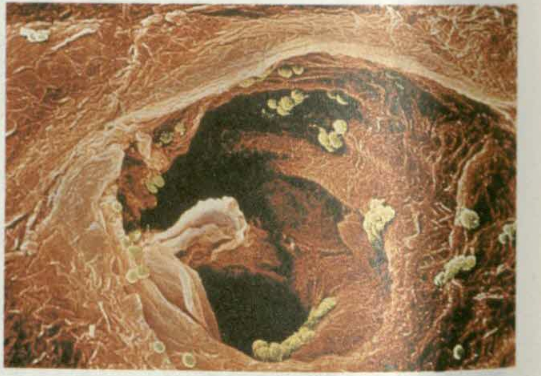
The human eye, like many parts of the body, rapidly adjusts to changes. In a darkened room, the pupil of the eye opens wide and so lets in more light, *left.* If the room lights are turned up, the pupil automatically shrinks within seconds, *right.*



The brain is one of the body's most complicated parts. The outer surface of the brain is made up of more than 8 billion cells. A few of these cells are shown in the circle.



The heart is a powerful pump. It beats about 100,000 times each day as it sends blood throughout the body.



A microscopic view of the skin shows bacteria as tiny green balls. Countless bacteria live on the skin. These bacteria are harmless unless they enter the body through a break in the skin.

magnificent brain makes people able to think. They can compose silly rhymes or beautiful poetry. They can imagine a dream world or study the mysteries of the atom. No animal—no matter how cunning—and no computer—no matter how powerful—can think like a human being.

The brain and the exquisitely complex nervous system, which ramifies throughout the body, work in close collaboration with the blood-borne hormones. These are the body's inbuilt control systems, orchestrating all that we are and we do.

What the body is made of

The human body has many parts. This section of the article describes the organization of the body, from its basic unit—the cell—to its integrated systems.

Chemical elements and molecules. Like all things—living and nonliving—the human body consists of atoms of chemical elements. The most common chemical elements in the body are carbon, hydrogen, nitrogen, and oxygen. The body also contains smaller amounts of many other elements, including calcium, iron, phosphorus, potassium, and sodium.

Atoms of chemical elements combine and form microscopic structures called *molecules.* The most common molecule in the human body is water. A molecule of water consists of two atoms of hydrogen and one atom of oxygen. Water makes up about 65 per cent of the body. Most of the chemical reactions that occur in the body require water.

Except for water, all of the chief molecules in the body contain the element carbon. The most important carbon-containing molecules are large, complicated structures called *macromolecules.* There are four main kinds of macromolecules in the body: *carbohydrates, lipids, proteins,* and *nucleic acids.* Carbohydrates provide energy that powers all the body's activities. Lipids have several jobs. Some lipids, particularly the fats, store extra fuel. Other lipids serve as one of the building materials for the cells that make up the body. Proteins also have various duties. Many proteins serve as building blocks for cells. Other proteins, called *enzymes,* speed up the chemical reactions within the body. Nucleic acids carry instructions that tell each cell how to perform its particular jobs. For more information on macromolecules, see the article **Life** (The chemical basis of life).

Cells and tissues. The cell is the basic unit of all living things. The cells of the human body consist chiefly of molecules of water, proteins, and nucleic acids. The molecules that make up the cells are not alive, but the cells themselves are living things. Each of the body's cells is able to take in food, get rid of wastes, and grow. Most of the cells can also reproduce. A thin covering consisting of lipid molecules encloses each cell. This lipid envelope permits only certain substances to enter or leave the cell.

Nearly all the cells in the body are too tiny to see without a microscope. Yet packed within each cell is the machinery that the cell needs to carry out its many activities. For a detailed discussion of a cell's machinery and how it works, see the article **Cell** (Inside a living cell; The work of a cell).

The body has many basic kinds of cells, such as blood cells, muscle cells, and nerve cells. Each kind of cell has special features and jobs. Cells of the same type form tissues. The body has four chief kinds of tissues. (1) *Connective tissue* helps support and join together various parts of the body. Most connective tissue is strong and elastic. (2) *Epithelial tissue* covers the body surface and so forms the skin. It also lines such body openings as the mouth and throat. Epithelial tissue prevents harmful substances from entering the body. (3) *Muscle tissue* consists of threadlike fibres that can *contract* (shorten). Muscle tissue makes it possible for the body to move. (4) *Nervous tissue* carries signals. Its system of nerve cells permits various parts of the body to communicate with one another.

Organs and organ systems. An organ consists of two or more kinds of tissues joined into one structure that has a certain task. The heart, for example, is an organ whose job is to pump blood throughout the body. Connective tissue, muscle tissue, and nervous tissue make up the heart.

Groups of organs form organ systems. Each organ system carries out a major activity in the body. For example, the digestive system consists of various organs that enable the body to use food. Similarly, the nervous system is made up of organs that carry messages from one part of the body to another. The remainder of this article discusses the main organ systems of the human body. For more detailed descriptions of the major organs and organ systems, see the articles listed in the *Related articles* at the end of this article.

The skin

The skin, which is sometimes called the *integumentary system,* is the largest organ of the body. If the skin of a 68-kilogram person was spread out flat, it would cover about 2 square metres. Skin has three layers: (1) the epidermis, (2) the dermis, and (3) the subcutaneous tissues.

The epidermis forms the outermost layer of the skin. It serves as a barrier between the outside world and the inner tissues of the body. The outer portion of the epidermis consists of tough, dead cells that prevent bacteria, chemicals, and other harmful substances from entering the body. It also protects the body's inner tissues from the harsh rays of the sun and prevents the loss of water from these tissues.

The dermis is the middle layer of the skin. The dermis helps keep the temperature of the body within its normal range. The body produces tremendous amounts of heat as it uses food. Some of this heat escapes from the body through the blood vessels in the dermis. When the body needs to retain heat, these blood vessels narrow and so limit heat loss. When the body needs to give off heat, the blood vessels in the dermis expand and so increase heat loss. The sweat glands, which are part of the epidermis, also help control body temperature. These glands produce sweat, which is released through pores on the skin surface. As the sweat evaporates from the surface, it cools the body.

The dermis also serves as an important sense organ. Nerve endings within the dermis respond to cold, heat, pain, pressure, and touch.

Subcutaneous tissues form the innermost layer of the skin. This layer provides extra fuel for the body. The fuel is stored in fat cells. The subcutaneous layer also helps retain body heat, and it cushions the inner tissues against blows to the body.

The skeletal system

The skeleton of an adult consists of more than 200 bones. The skeleton forms a strong framework that supports the body. It also helps protect the internal organs. For example, the brain is shielded by the skull, the spinal cord by the spinal column, and the heart and lungs by the ribs.

The skeleton works together with the muscles in enabling the body to move. The bones of the shoulders and arms, for instance, serve as levers against which the muscles that move the arm can pull. The place where bones meet is called a joint. There are two basic kinds of joints. (1) *Freely movable joints,* such as the elbow, knee, and shoulder joints, permit varying degrees of motion. The bones of a movable joint are held together by bundles of tough, flexible connective tissue called *ligaments.* (2) *Immovable joints* do not permit any movement of the bones. The bones of the skull, except for the jawbones, meet in fixed joints.

The skeleton serves as more than a framework for the body and a system of levers to help move the body. Bone tissue contains various kinds of cells that play a major role in keeping the blood healthy. The cells of bone *marrow*—the soft, fatty core of many bones—produce new blood cells and release them into the bloodstream. Two kinds of bone cells regulate the mineral content of the blood. One kind removes calcium, phosphorus, and other minerals from the blood and deposits them in the bone. The other kind dissolves old mineral deposits and releases the minerals back into the bloodstream as needed.

The muscular system

The muscular system moves the body. The body has more than 600 muscles, each of which consists of special fibres that can contract. When a muscle contracts, it pulls the tissue to which it is attached. This pulling results in movement.

The muscles of the human body can be divided into two main types: (1) skeletal muscles and (2) smooth muscles. A third kind of muscle, *cardiac muscle,* is found only in the heart. It has features of both skeletal muscle and smooth muscle.

Skeletal muscles are attached to the bones. They move the bones of the arms, legs, fingers, and other parts of the skeleton. We can consciously control the skeletal muscles, and so they are sometimes called *voluntary muscles.* The fibres that make up a skeletal mus-

Anatomy of the human body

Each page in this series shows one or more of the human body's major systems. The index below keys the numbers found in the illustrations to an alphabetical list of each system's parts.

Skeletal system

Breastbone (sternum)	1
Calf bone (fibula)	2
Carpals (wrist bones)	3
Cheekbone (zygomatic bone)	4
Clavicle (collarbone)	5
Coccyx	6
Collarbone (clavicle)	5
Femur (thighbone)	7
Fibula (calf bone)	2
Finger bones (phalanges)	8
Frontal bone	9
Hipbone	11
Ilium	11a
Ischium	11b
Pubis	11c
Humerus	12
Ilium	11a
Ischium	11b
Jawbone, lower (mandible)	13
Jawbone, upper (maxilla)	14
Kneecap (patella)	15
Mandible (jawbone, lower)	13
Maxilla (jawbone, upper)	14
Metacarpals (hand bones)	10
Nasal bone	16
Occipital bone	17
Palm bones (metacarpals)	10
Parietal bone	18
Patella (kneecap)	15
Phalanges (finger bones)	8
Pubis	11c
Radius	19
Ribs	20
Sacrum	21
Scapula (shoulder blade)	22
Shinbone (tibia)	23
Shoulder blade (scapula)	22
Sphenoid bone	24
Spinal column (vertebrae)	25
Sternum (breastbone)	1
Teeth	26
Temporal bone	27
Thighbone (femur)	7
Tibia (shinbone)	23
Ulna	28
Vertebrae (spinal column)	25
Wrist bones (carpals)	3
Zygomatic bone (cheekbone)	4

Muscular system

Abdominal oblique, external	29
Abductor pollicis longus	30
Adductor longus	31
Biceps	32
Brachioradialis	33
Deltoid	34
Extensor pollicis brevis	35
Frontal muscle	36
Gastrocnemius	37
Gracilis	38
Masseter	39
Orbicularis oculi	40
Orbicularis oris	41
Pectineus	42
Pectoralis major	43
Rectus abdominis	44
Rectus femoris	45
Sartorius	46
Serratus anterior	47
Sternocleidomastoid	48
Sternohyoid	49
Temporal muscle	50
Tensor fasciae latae	51
Trapezius	52
Triceps	53
Vastus lateralis	54
Vastus medialis	55

Digestive system

Appendix, vermiform	56
Oesophagus	57
Gall bladder	58
Intestine, large	59
Intestine, small	60
Liver	61
Mouth	62
Pharynx	63
Rectum	64
Salivary glands	65
Stomach	66

Respiratory system

Bronchus	67
Diaphragm	68
Larynx	69
Lung	70
Trachea (windpipe)	71
Windpipe (trachea)	71

Circulatory system

Heart	72
Spleen	*
Arteries	
Aorta	73
Axillary	74
Brachial	75
Carotid, common	76
Carotid, external	77
Carotid, internal	78
Coronary	79
Femoral	80
Iliac, common	81
Iliac, external	82
Pulmonary	83
Radial	84
Renal	85
Subclavian	86
Temporal, superficial	87
Thyroid, superior	88
Ulnar	89
Veins	
Brachial	90
Cephalic	91
Femoral	92
Iliac, common	93
Iliac, external	94
Jugular, external	95
Jugular, internal	96
Pulmonary	97
Renal	98
Saphenous, great	99
Subclavian	100
Vena cava, inferior	101
Vena cava, superior	102

Urinary system

Bladder	103
Kidney	104
Ureter	105
Urethra	106

Reproductive system

Male	
Prostate gland	107
Seminal vesicle	108
Testicle	109
Vas deferens	110
Female	
Fallopian tube	111
Ovary	112
Uterus	113
Vagina	114

Endocrine system

Adrenal gland	115
Ovary	112
Pancreas	116
Pineal gland	117
Pituitary gland	118
Testicle	109
Thymus	119
Thyroid gland	120

Nervous system

Brain	121
Cerebellum	121a
Cerebrum	121b
Pons	121c
Cerebellum	121a
Cerebrum	121b
Femoral nerve	122
Median nerve	123
Pons	121c
Radial nerve	124
Sciatic nerve	125
Spinal cord	126
Spinal nerves (31 pairs)	127
Ulnar nerve	128

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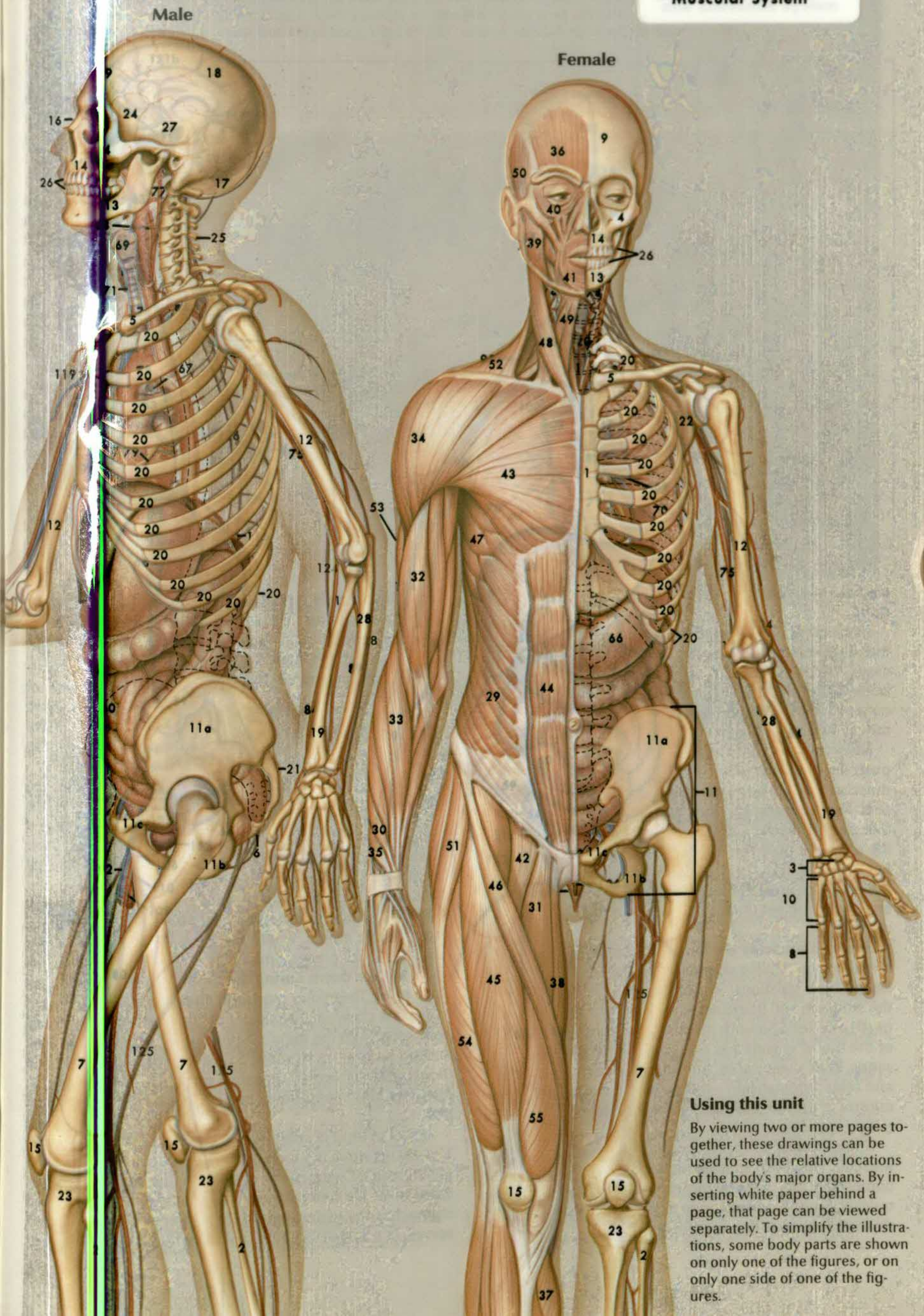
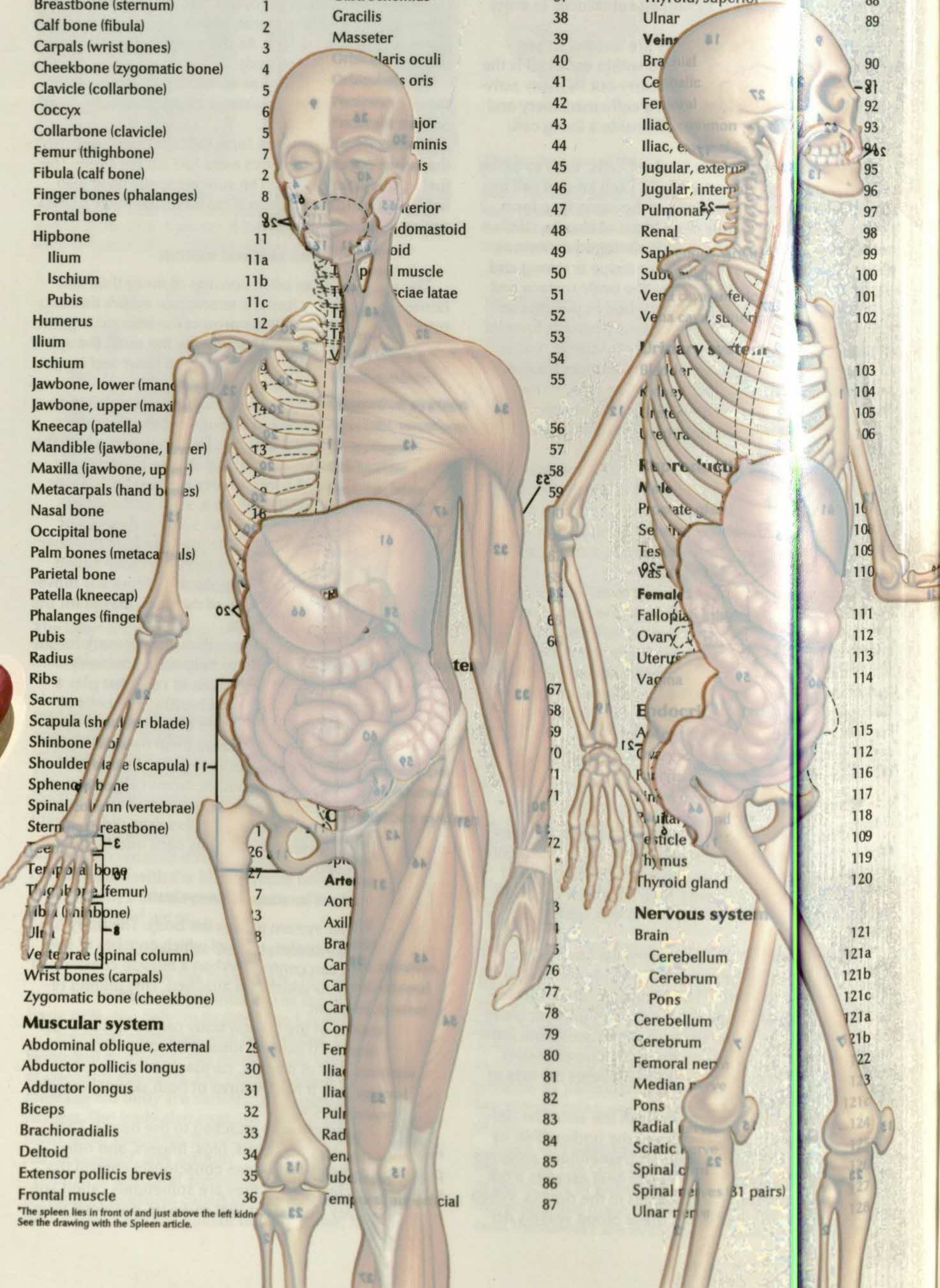
*The spleen lies in front of and just above the left kidney (104). See the drawing with the Spleen article.

Skeletal System and Muscular System



Using this unit

By viewing two or more pages together, these drawings can be used to see the relative locations of the body's major organs. By inserting white paper behind a page, that page can be viewed separately. To simplify the illustrations, some body parts are shown on only one of the figures, or on only one side of one of the figures.



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Sk

Breastbone (sternum)	1
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Jawbone, upper (maxi	14
Kneecap (patella)	
Mandible (jawbone, er)	13
Maxilla (jawbone, up)	
Metacarpals (hand b es)	
Nasal bone	16
Occipital bone	
Palm bones (metaca als)	
Parietal bone	
Patella (kneecap)	
Phalanges (finger	
Pubis	
Radius	
Ribs	
Sacrum	
Scapula (sh r blade)	
Shinbone	
Shoulder e (scapula)	
Spheno b ne	
Spinal nn (vertebrae)	
Stern reastbone)	1
e	26
Te bone	27
T (femur)	7
ib (hinbone)	3
Ul	8
Ve te rae (spinal column)	
Wrist bones (carpals)	
Zygomatic bone (cheekbone)	

Muscular system

Abdominal oblique, external	29
Abductor pollicis longus	30
Adductor longus	31
Biceps	32
Brachioradialis	33
Deltoid	34
Extensor pollicis brevis	35
Frontal muscle	36
Gastrocnemius	37
Gracilis	38
Masseter	39
laris oculi	40
s oris	41
	42
ajor	43
minis	44
is	45
	46
terior	47
idomastoid	48
oid	49
T p l muscle	50
T sciae latae	51
Tr	52
Tr	53
V	54
	55
	56
	57
	58
	59
	6
	6

te

	67
	8
	9
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C	
Spl	*

Arte

Aort	3
Axil	
Bra	5
Car	76
Car	77
Car	78
Cor	79
Fem	80
Iliac	81
Iliac	82
Pul	83
Rad	84
en	85
ub	86
Temp cial	87
Thyroid, superior	88
Ulnar	89

Vein

Bra	90
Ce	91
Fe	92
Iliac,	93
Iliac, e	94
Jugular, extern	95
Jugular, intern	96
Pulmona	97
Renal	98
Saph	99
Sub	100
Ve fe	101
Ve , su	102

U a y s te

er	103
K ey	104
te	105
e ra	06

R pro uct

M le

Pr ate	10
Se	10
Tes	109
Vas	110

Femal

Fallopia	111
Ovary	112
Uterus	113
Va	114

E

A	115
	112
P	116
in	117
uitar	118
esticle	109
hymus	119
Thyroid gland	120

Nervous syste

Brain	121
Cerebellum	121a
Cerebrum	121b
Pons	121c
Cerebellum	121a
Cerebrum	21b
Femoral ner	22
Median	3
Pons	
Radial	
Sciatic	
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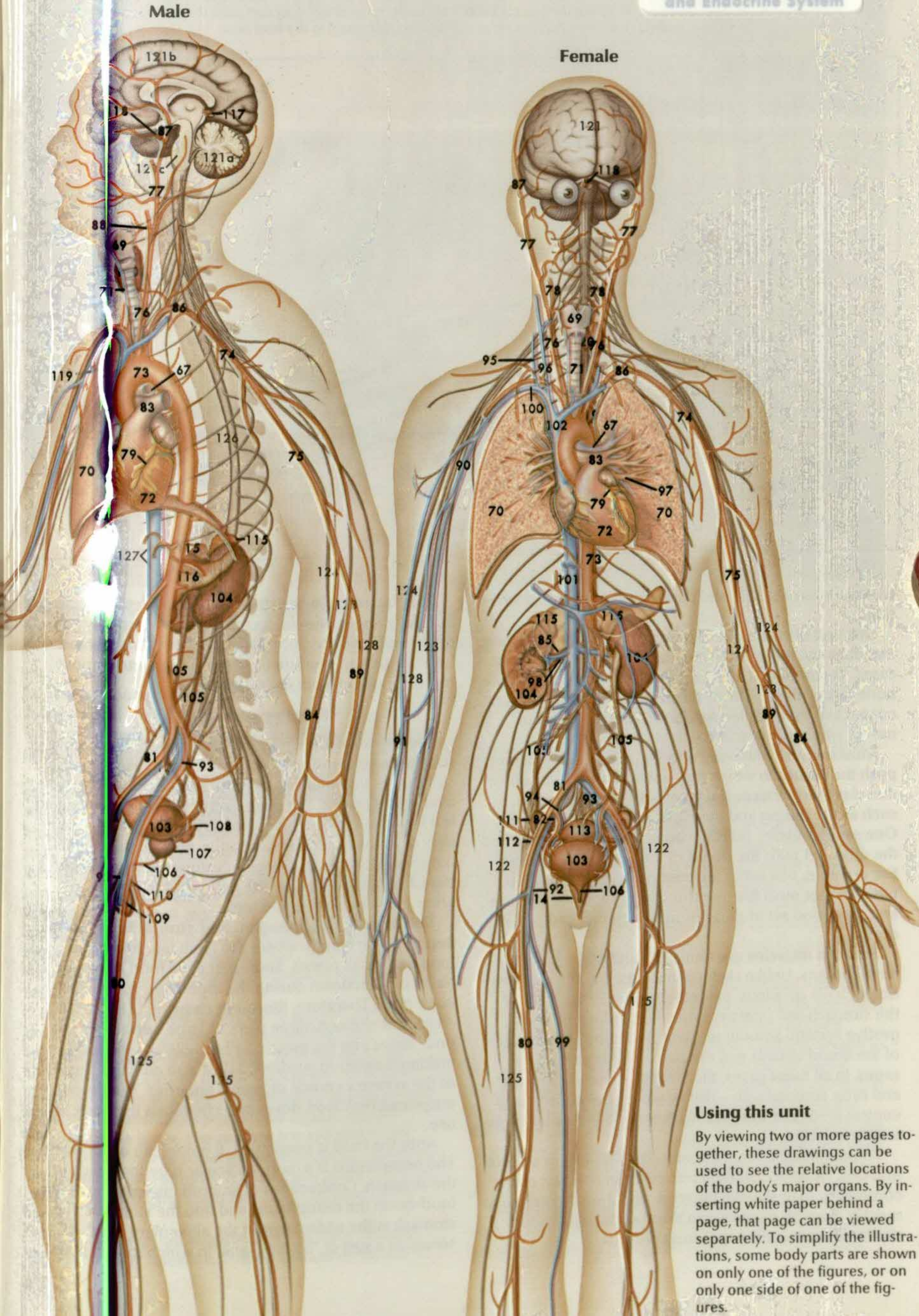
*The spleen lies in front of and just above the left kidn
See the drawing with the Spleen article.

Respiratory System and Circulatory System



Using this unit

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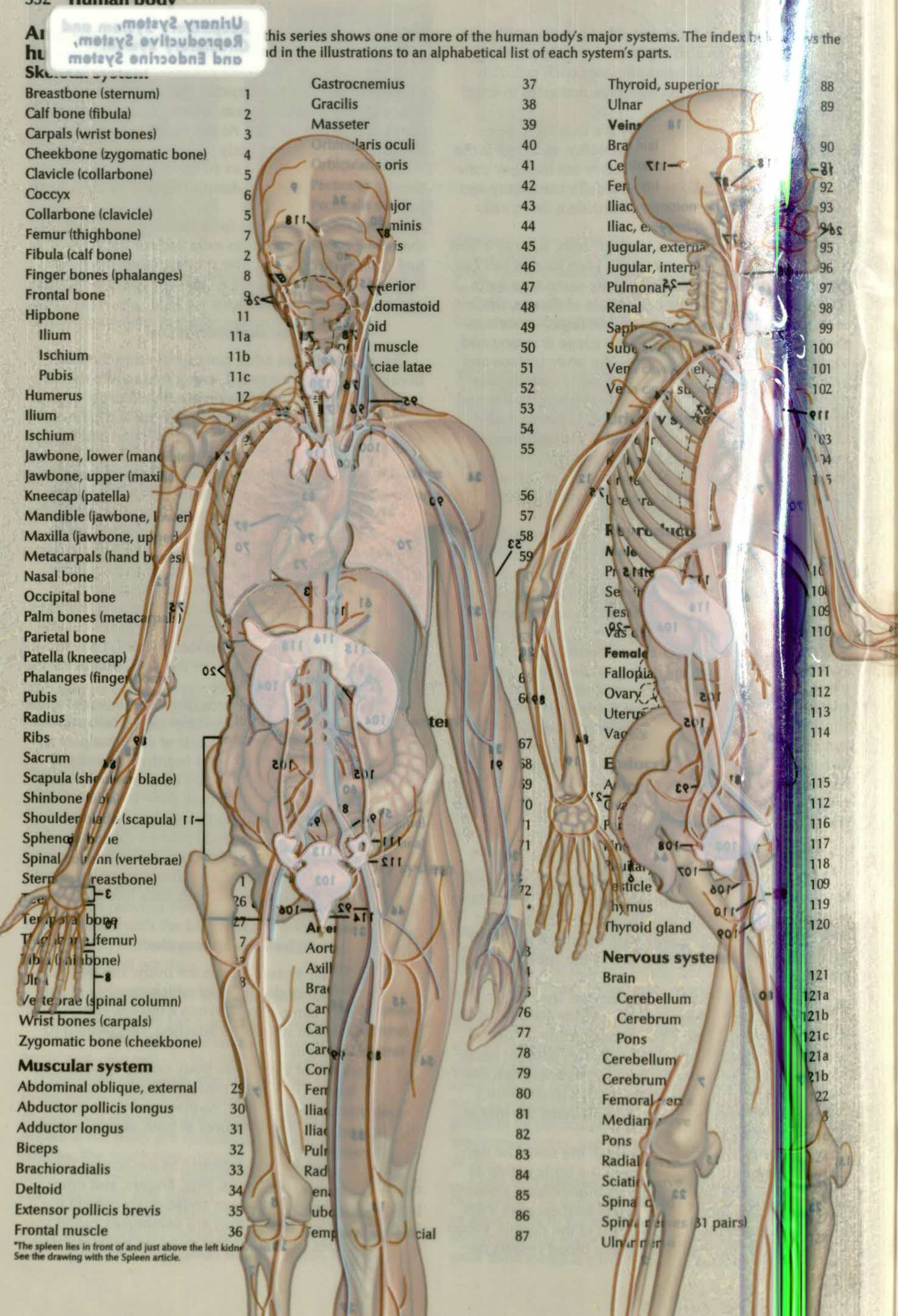

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this series shows one or more of the human body's major systems. The index b ys the d in the illustrations to an alphabetical list of each system's parts.

Sk

Breastbone (sternum)	1
Calf bone (fibula)	2
Carpals (wrist bones)	3
Cheekbone (zygomatic bone)	4
Clavicle (collarbone)	5
Coccyx	6
Collarbone (clavicle)	5
Femur (thighbone)	7
Fibula (calf bone)	2
Finger bones (phalanges)	8
Frontal bone	9
Hipbone	11
Ilium	11a
Ischium	11b
Pubis	11c
Humerus	12
Ilium	[illegible]
Ischium	[illegible]
Jawbone, lower (man	[illegible]
Jawbone, upper (maxi	[illegible]
Kneecap (patella)	[illegible]
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Maxilla (jawbone, up	[illegible]
Metacarpals (hand b es)	[illegible]
Nasal bone	[illegible]
Occipital bone	[illegible]
Palm bones (metaca)	[illegible]
Parietal bone	[illegible]
Patella (kneecap)	[illegible]
Phalanges (finge	[illegible]
Pubis	[illegible]
Radius	[illegible]
Ribs	[illegible]
Sacrum	[illegible]
Scapula (sh blade)	[illegible]
Shinbone	[illegible]
Shoulder (scapula)	[illegible]
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Spinal nn (vertebrae)	[illegible]
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Extensor pollicis brevis	35
Frontal muscle	36
Gastrocnemius	37
Gracilis	38
Masseter	39
laris oculi	40
oris	41
[illegible]	42
jor	43
minis	44
is	45
[illegible]	46
erior	47
domastoid	48
oid	49
muscle	50
ciae latae	51
[illegible]	52
[illegible]	53
[illegible]	54
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[illegible]	56
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[illegible]	72
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Ar er

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Axill	[illegible]
Brac	[illegible]
Car	76
Car	77
Car	78
Cor	79
Fem	80
Iliac	81
Iliac	82
Pul	83
Rad	84
en	85
ubc	86
emp cial	87
Thyroid, superior	88
Ulnar	89

Vein

Bra	90
Ce	91
Fe	92
Iliac,	93
Iliac, e	94
Jugular, extern	95
Jugular, inter	96
Pulmona	97
Renal	98
Saph	99
Sub	100
Ven er	101
Ve su	102
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
U e ra	

R ucti

M le

Pr	[illegible]
Se	[illegible]
Tes	109
Vas	110

Female

Fallopia	111
Ovary	112
Uterus	113
Vag	114

E

A	115
O	112
P	116
in	117
uitar	118
sticle	109
ymus	119
Thyroid gland	120

Nervous syste

Brain	121
Cerebellum	121a
Cerebrum	[illegible]
Pons	121c
Cerebellum	[illegible]
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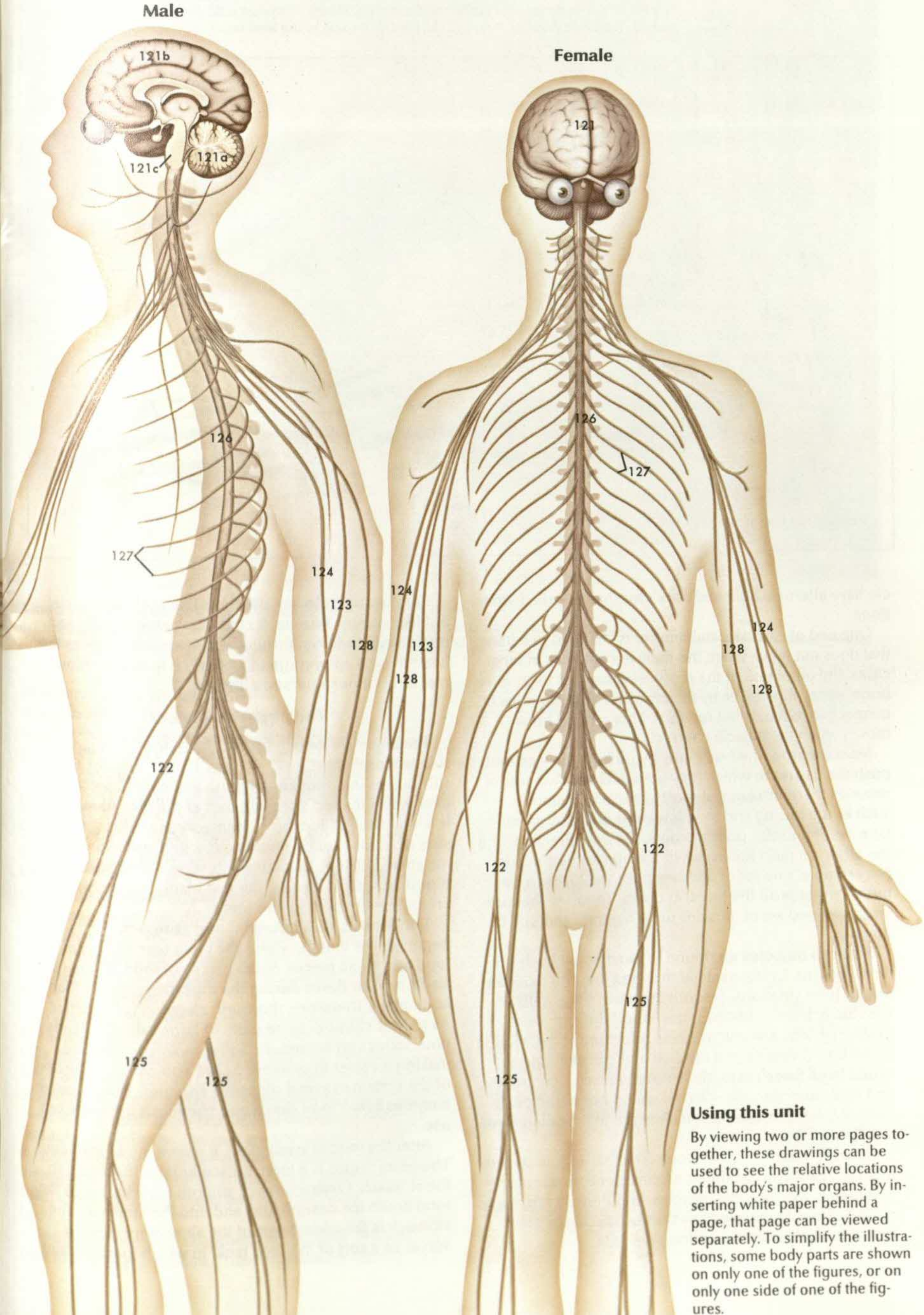
Nervous system



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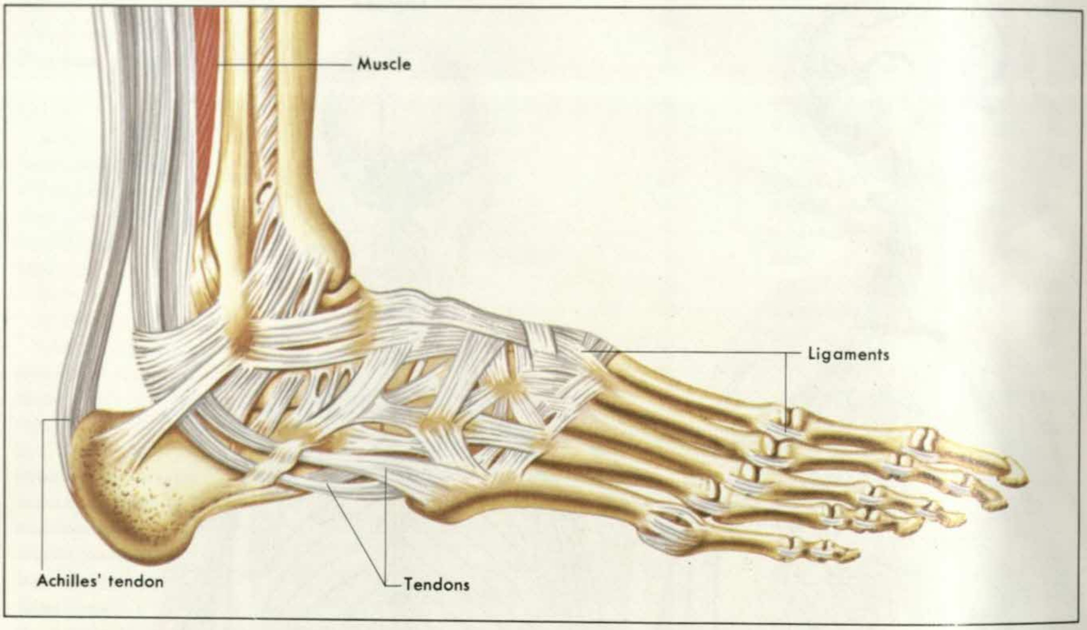
Ligaments and tendons Ligaments and tendons consist of tough, elastic connective tissue. Ligaments connect one bone to another. They hold the bones in place but still allow some movement. Tendons connect a muscle to a bone. When the muscle contracts, the strong, cablelike tendon pulls the bone to which it is attached. The large Achilles' tendon links the calf muscle to the heel bone.



cle have alternate light and dark crossbands called *striations.*

One end of each skeletal muscle is attached to a bone that does not move when the muscle contracts. In most cases, the other end of the muscle is attached to another bone, either directly or by means of cordlike bundles of connective tissue called *tendons.* This second bone moves when the muscle contracts.

Muscles move the body only by pulling. They cannot push the tissues to which they are attached. Two sets of muscles therefore control most skeletal movements, such as the raising and then lowering of the forearm. One set of muscles pulls the bones in one direction, and the other set pulls the bones in the opposite direction. For example, one set of muscles pulls the forearm up, but it cannot push the forearm down. To lower the forearm, a second set of muscles must contract and pull it down.

Smooth muscles are found in most of the body's internal organs. Unlike skeletal muscles, smooth muscles do not have striations. Smooth muscles in the walls of the stomach and intestines move food through the digestive system. Smooth muscles also control the width of the blood vessels and the size of the breathing passages. In all these cases, the smooth muscles contract and relax automatically—that is, we do not consciously control them. For this reason, they are often called *involuntary muscles.*

Smooth muscles cannot contract as rapidly as skeletal muscles. However, smooth muscles can contract more completely than skeletal muscles, and they do not tire as quickly. Smooth muscles can thus produce powerful, rhythmic contractions over long periods.

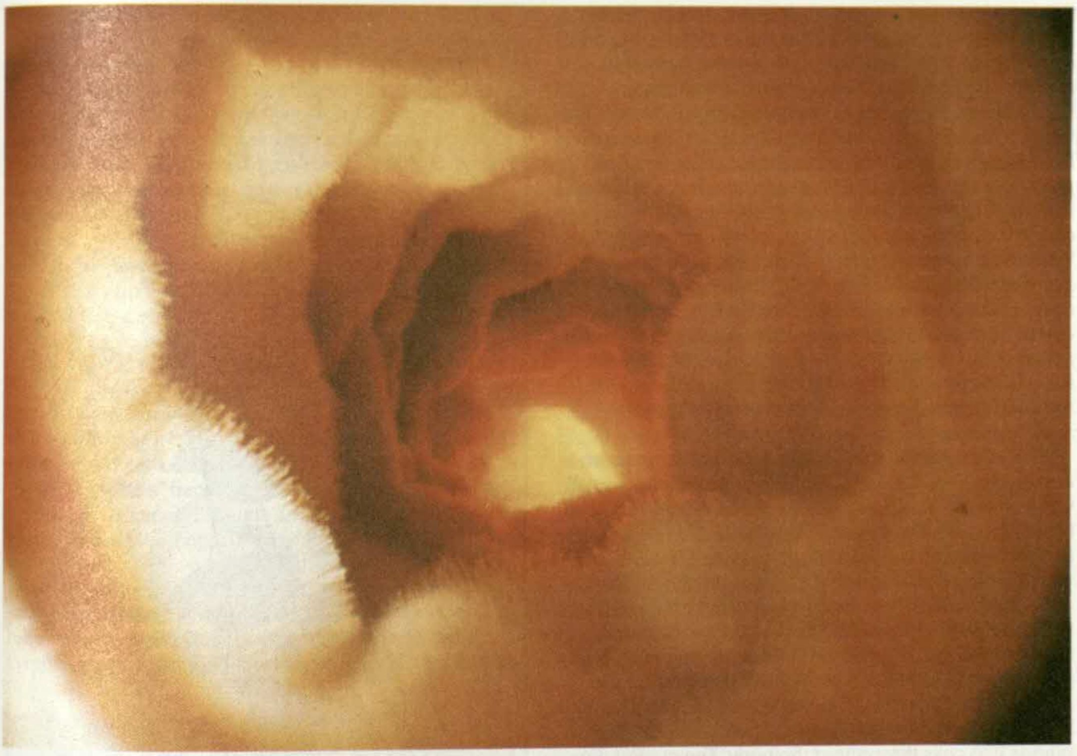
Cardiac muscle has striations like skeletal muscle. But like smooth muscle, it contracts automatically and rhythmically without tiring. Cardiac muscle enables the heart to beat an average of 70 times a minute without rest throughout a person's lifetime.

The digestive system

The digestive system breaks down food into simple substances that the cells can use. It then absorbs these substances into the bloodstream and eliminates any leftover waste matter. The main part of the digestive system is a long tube called the *alimentary canal.* This tube consists of (1) the mouth, oesophagus, and stomach; and (2) the small intestine and large intestine. Other parts of the digestive system include the gall bladder, liver, pancreas, salivary glands, and teeth.

The mouth, oesophagus, and stomach. Digestion begins in the mouth, where the teeth tear and grind food into small pieces. Small pieces of food are more easily broken down during the digestive process than large ones. Therefore, thorough chewing is important. As food is chewed, three pairs of large salivary glands pour saliva into the mouth. Saliva moistens the food, making it easier to swallow. Saliva also contains the first of the system's several digestive enzymes. The digestive enzymes break food down into chemicals the body can use.

After the food is swallowed, it enters the oesophagus. The oesophagus is a long, muscular tube that leads to the stomach. Contractions of smooth muscles move the food down the oesophagus and into the stomach. The stomach is the widest part of the alimentary canal. It serves as a sort of "holding tank" in which food remains



A magnified cross section of the small intestine shows the tiny, fingerlike structures that line this organ. These structures, called *villi,* increase the surface area of the small intestine. They enable the organ to absorb large amounts of useful substances from digested food.

for several hours. During this time, the stomach produces an acid and an enzyme that further break down much of the food. Muscle contractions mix the partly digested food into a thick liquid called *chyme.*

The small intestine and large intestine. Chyme passes from the stomach into the small intestine at a steady rate. Various digestive enzymes complete the breakdown of the food within the first section of the small intestine. The small intestine produces some of these enzymes. The rest are made by the pancreas. The pancreatic enzymes empty into the small intestine through a *duct* (tube). *Bile,* a liquid made by the liver and stored in the gall bladder, also enters the small intestine through a duct. Bile does not contain digestive enzymes, but it aids digestion by breaking up large molecules of fatty foods.

By the time the food leaves the first section of the small intestine, it has been completely digested. Special cells line the walls of the remainder of the small intestine. These cells absorb useful substances from the digested food. The absorbed substances enter the blood. Some of the substances are carried directly to cells throughout the body. The rest are transported to the liver. The liver stores some of the substances, releasing them as the body requires. It chemically alters the other substances, changing them into forms needed by the body.

The substances not absorbed by the small intestine pass to the large intestine. These substances consist of water, minerals, and wastes. The large intestine absorbs most of the water and minerals, which then enter the bloodstream. The wastes move down toward the *rectum,* the end of the large intestine, and leave the body as faeces.

The respiratory system

The respiratory system consists of the organs of breathing. These organs include the nose, the *trachea* (windpipe), and a pair of lungs. The respiratory system has two main jobs. (1) It provides the body with oxygen. (2) It rids the body of carbon dioxide. The cells of the body need oxygen to break down and so release the energy in food. During this process, carbon dioxide forms as a waste product.

Breathing involves the acts of inhaling and exhaling. Inhaling occurs as the chest cavity expands. As the chest expands, so do the lungs. Air from the atmosphere rushes in and fills the enlarged lungs. Exhaling occurs as the chest cavity shrinks, which pushes air out of the lungs. Inhaling and exhaling result chiefly from contractions of the *diaphragm,* a large muscle that forms the floor of the chest cavity. As the diaphragm contracts, the cavity expands. As it relaxes, the cavity shrinks. The muscles that move the ribs also play a part in the breathing process.

The air passages. When we inhale, air enters the body through the nose. The air flows from the nostrils to the nasal passages. The nasal passages are lined with tiny hairlike structures and a sticky substance called *mucus.* These structures and the mucus filter dust and dirt from the air. In addition, cold air is warmed and moistened as it moves through the nasal passages. From the nose, the air passes through the *pharynx* (the cavity behind the nose and mouth) and the *larynx* (the voice box). The air then enters the trachea.

The trachea carries the air toward the lungs. Before reaching the lungs, the trachea splits into two tubes called the *primary bronchi.* Each tube enters one lung. Within the lungs, the primary bronchi divide into smaller and smaller tubes, finally branching into extremely tiny tubes called *bronchioles.* The bronchioles end in hundreds of millions of thin-walled structures called *alveoli* or *air sacs.* The alveoli give the lungs a tremendously extended surface area. If the air sacs were flattened out, the lungs would cover from 55 to 90 square metres.

The exchange of carbon dioxide and oxygen occurs in the alveoli. Each alveolus is surrounded by a network of small blood vessels. Like the alveoli, these small blood vessels have extremely thin walls. Blood that enters the vessels has a high level of carbon dioxide, which it picked up from the body tissues. It contains little oxygen. The carbon dioxide leaves the blood and moves through the walls of the blood vessels and alveoli into the lungs. Oxygen from the air in the lungs then passes through the walls of the alveoli and blood vessels and into the blood. The blood, now rich in oxygen, leaves the lungs and travels to the heart. The heart then pumps it to cells throughout the body. The carbon dioxide is finally expelled from the lungs when we exhale.

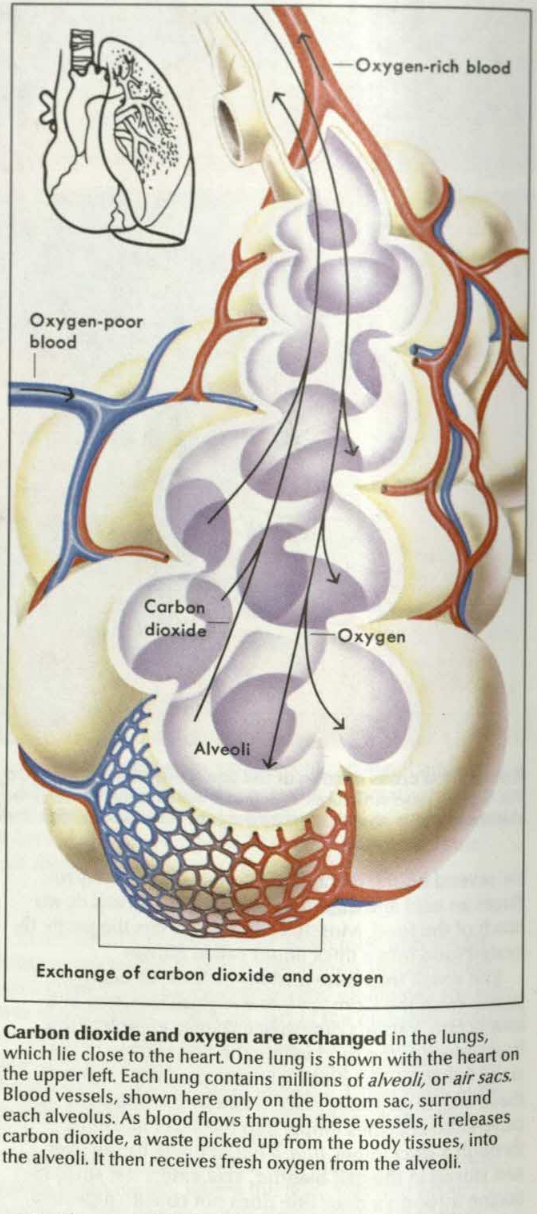
The circulatory system

The circulatory system moves blood throughout the body. Blood transports food and oxygen to the cells and carries away carbon dioxide and other wastes. The cells cannot live without a continuous supply of fresh blood. The circulatory system also carries disease-fighting substances that help protect the body. In addition, it transports chemical messengers called *hormones.* Hormones are discussed in the section of this article called *The endocrine system.*

The circulatory system consists chiefly of (1) the heart, (2) the blood vessels, (3) the blood, and (4) the lymphatic system.

The heart is a hollow muscle that pumps blood through the circulatory system by contracting and relaxing rhythmically. The heart actually consists of two pumps that lie side by side. The left side of the heart makes up the stronger pump. It receives oxygen-rich blood from the lungs and sends it to cells throughout the body. The blood, which picks up carbon dioxide and other wastes from the cells, returns to the right side of the heart. This weaker pump moves the blood to the lungs and then back to the left side of the heart. In the lungs, the carbon dioxide is removed from the blood, and oxygen is added.

The blood vessels form a branching network of about 97,000 kilometres. They can be divided into three types (1) *Arteries* carry blood from the heart. (2) *Veins* carry blood to the heart. (3) *Capillaries* connect the arteries and veins.



Carbon dioxide and oxygen are exchanged in the lungs, which lie close to the heart. One lung is shown with the heart on the upper left. Each lung contains millions of *alveoli,* or *air sacs.* Blood vessels, shown here only on the bottom sac, surround each alveolus. As blood flows through these vessels, it releases carbon dioxide, a waste picked up from the body tissues, into the alveoli. It then receives fresh oxygen from the alveoli.

Blood leaves the left side of the heart through the *aorta.* This vessel is the largest artery in the body. Several major arteries branch off the aorta. These arteries, in turn, divide into smaller and smaller vessels. Finally, the smallest arteries empty into the tiny capillaries. Through the thin walls of the capillaries, food and oxygen in the blood are exchanged for carbon dioxide and other wastes from individual cells.

From the capillaries, the blood enters small veins, which join larger and larger veins. Finally, the blood enters the right side of the heart through the *superior vena cava* and *inferior vena cava,* the body's two largest veins. The right side of the heart then pumps the blood through the *pulmonary arteries* to the capillaries surrounding the air sacs in the lungs. The blood returns from the lungs to the left side of the heart through four *pulmonary veins.* The left side of the heart then pumps the blood out through the aorta, and the blood's journey begins once more.

The blood consists of a liquid and three kinds of solid particles called *formed elements.* The liquid, which makes up 55 to 65 per cent of the total volume of blood, is known as *plasma.* It carries many important substances. The food that enters the blood from the intestines and liver dissolves in the plasma, much as sugar dissolves in water. The plasma transports the dissolved food throughout the body. Many of the wastes that the blood picks up from the body tissues are carried in the plasma. These wastes include ammonia, urea, and much of the carbon dioxide.

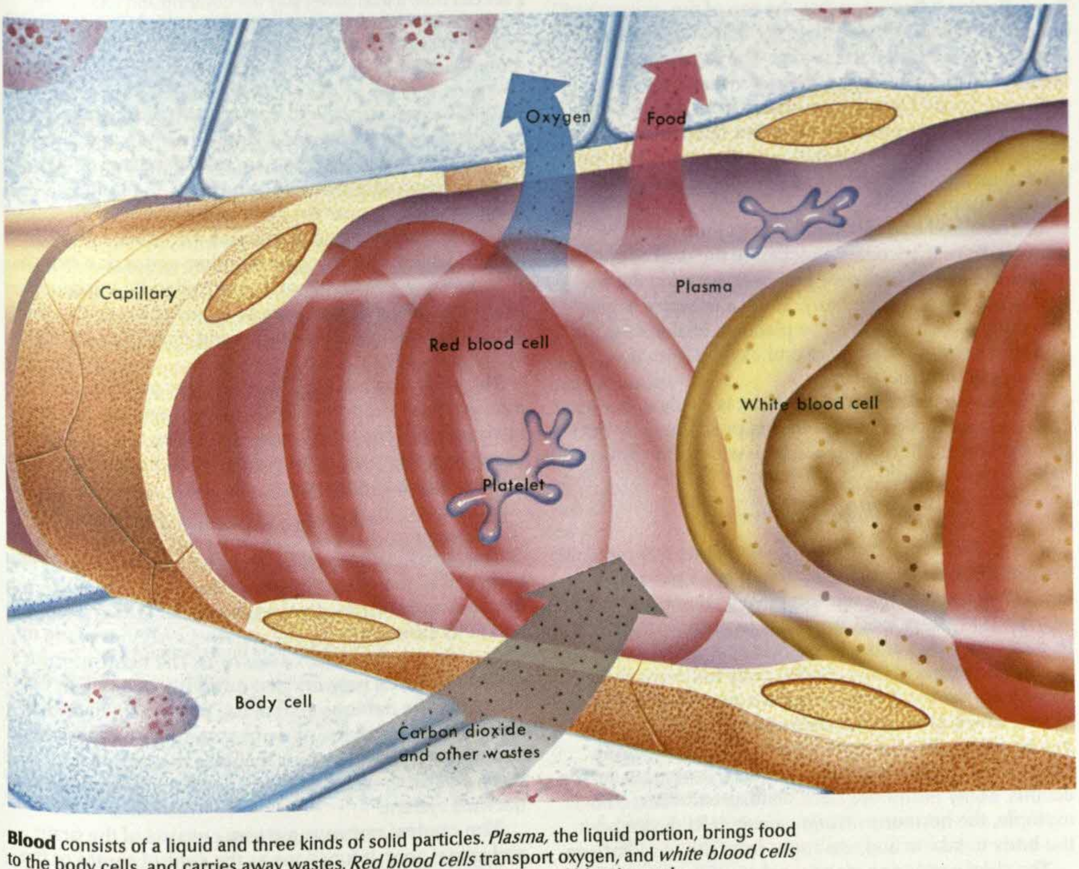
The formed elements in blood consist of *red blood cells, white blood cells,* and *platelets.* Red blood cells carry oxygen from the lungs to the body tissues. They also carry some of the carbon dioxide from the tissues. White blood cells help protect the body from disease. These cells attack bacteria, viruses, poisons, and other harmful substances. Platelets are disclike structures that help prevent bleeding from damaged blood vessels. Together with various proteins in the plasma, platelets seal broken vessels by forming a clot.

The lymphatic system consists of a network of tubes that carries a clear, watery fluid called *lymph.* Lymph comes from the blood and eventually returns to it. Water, proteins, and dissolved food leave the blood through the capillary walls. This fluid, which is known as *interstitial fluid,* bathes and nourishes the cells of the body tissues. The fluid then drains into tiny, open-ended tubes called *lymphatic vessels.* At this point, the fluid is known as *lymph.*

The lymph flows through the small tubes into larger and larger lymphatic vessels. *Lymph nodes* occur at various points along the lymphatic vessels. These beadlike structures produce many white blood cells, which filter harmful substances out of the lymph. Eventually, all the lymph flows into either the *thoracic duct* or the *right lymphatic duct.* The lymph drains from these ducts into veins near the neck and so rejoins the blood.

The urinary system

The urinary system removes various wastes from the blood and flushes them from the body. The chief organs of this system are the two kidneys. Each kidney has about a million microscopic filtering units called *nephrons.* As blood passes through a nephron, a complicated network of capillaries and tubes filters out a small amount of water together with urea, sodium chloride, and certain other wastes. This filtered-out material forms a yellowish fluid called *urine.* Two tubes called *ureters* carry urine from the kidneys to the *urinary bladder,* a hollow storage organ. Urine eventually is squeezed



Blood consists of a liquid and three kinds of solid particles. *Plasma,* the liquid portion, brings food to the body cells, and carries away wastes. *Red blood cells* transport oxygen, and *white blood cells* defend against disease. *Platelets* help prevent bleeding from damaged blood vessels.

out of the bladder by muscular contractions. It then leaves the body through a tube known as the *urethra.*

The reproductive system

The organs of the reproductive system enable men and women to have children. Human beings reproduce sexually. Sexual reproduction involves the union of sex cells. A new human being begins to develop after a sex cell produced by the father unites with a sex cell produced by the mother. The father's sex cells are called *sperm,* and the mother's are called *eggs.* The union of a sperm and an egg results in *fertilization.* The fertilized egg has all the information necessary for the development of a new human being.

The male reproductive system includes two *testicles,* which hang between the legs in a pouch called the *scrotum.* The testicles are glands that produce sperm. The sperm travel through tubes to the *penis,* an organ in front of the scrotum. Sperm leave a man's body through the penis.

Most of the female reproductive system lies inside the woman's body. Deep within the body are two glands called *ovaries,* each of which contains about 400,000 eggs. Only about 400 eggs will mature during a woman's childbearing years. About once a month, one of the ovaries releases an egg. The egg travels down a narrow duct called the *Fallopian tube.* The female body has two Fallopian tubes, one leading from each ovary. The Fallopian tubes open into the top of the *uterus,* a hollow, muscular organ. The other end of the uterus leads to a canal called the *vagina.* The vagina extends to the outside of the body, opening between the legs.

During sexual intercourse, sperm from the penis enters the vagina. Each sperm has a tiny tail and can swim. The sperm swim from the vagina to the uterus and into the Fallopian tubes. If an egg is present in one of the tubes, a sperm may fertilize it.

The fertilized egg cell continues its journey to the uterus, where it becomes attached to the wall of the organ. The cell divides over and over, forming the beginning of a developing baby. Soon, a complex organ called the *placenta* forms. The placenta enables the developing baby to obtain food and oxygen from the mother's bloodstream.

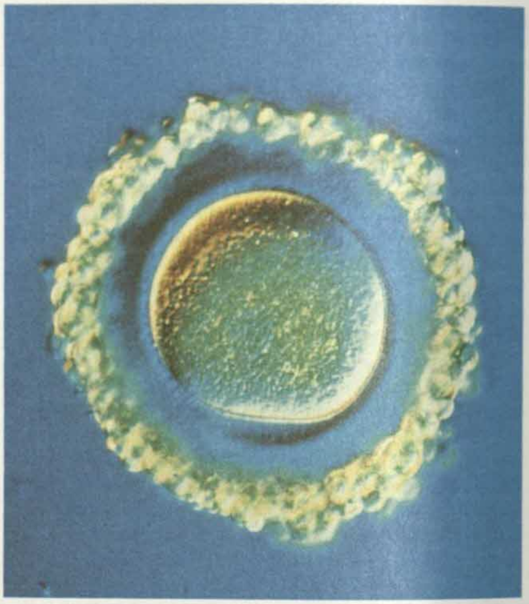
After about nine months, the baby is ready to be born. Powerful contractions of the uterus push the baby out through the mother's vagina, which widens to allow the baby to pass through.

The endocrine system

The endocrine system consists of glands that regulate various body functions.The system plays a major role in regulating growth, the reproductive process, and the way the body uses food. It also helps prepare the body to deal with stress and emergencies.

The endocrine glands control body functions by producing hormones. These chemicals are released into the blood, which carries them throughout the body. Hormones act as chemical messengers. After a hormone reaches the organs or tissues it affects, it triggers certain actions. Many hormones have widespread effects. For example, the hormone *insulin* causes cells throughout the body to take in and use sugar from the bloodstream.

The chief endocrine glands include the adrenal glands, the pituitary gland, the parathyroid glands, the sex glands, and the thyroid gland. The brain, the kidneys, the stomach, and the pancreas also have endocrine tissues and produce hormones. The pituitary gland, which lies near the base of the brain, is often called the *master gland.* It releases a number of hormones, which, in turn, regulate other endocrine glands. However, the pituitary itself is controlled by hormones produced by the *hypothalamus,* a part of the brain. The hypothalamus links the nervous and endocrine control systems.



One egg cell is released from an ovary about every 28 days during a woman's childbearing years. The egg is surrounded by a covering, which appears as a ring in the photograph above. If a sex cell from a man penetrates the covering and unites with the egg, a new human being begins to develop.

The body also has glands that do not produce hormones. These *exocrine glands* make chemicals that perform specific jobs in the area where they are released. Major exocrine products include the digestive juices, mucus, sweat, and tears.

The nervous system

The nervous system regulates and coordinates the activities of all the other systems of the body. It enables the body to adjust to changes that occur within itself and in its surroundings. The nervous system is made up of countless nerve cells, or *neurons.* The neurons form a communications network that extends to every part of the body. The nervous system has three main divisions. They are (1) the central nervous system; (2) the peripheral nervous system, which includes the eyes, ears, nose, and other sense organs; and (3) the autonomic nervous system.

The central nervous system consists of the brain and spinal cord. It functions as the control centre of the nervous system. The central nervous system receives information from the senses. It analyses this information and decides how the body should respond. It then sends instructions that trigger the required actions.

The central nervous system makes some simple decisions, such as directing the hand to pull away from a hot object, within the spinal cord. Such simple decisions are called *spinal reflexes.* Most decisions, however, involve the brain. The brain is an enormously complicated collection of billions of neurons. These neurons are linked together in precise patterns that enable the brain to think and remember. Much brain activity occurs at the conscious level. We are aware of decisions made at this level and can voluntarily control them. Other activity occurs at the subconscious level. This activity regulates the smooth muscles and is beyond voluntary control.

The peripheral nervous system is made up of the nerves that connect the central nervous system with every part of the body. These nerves include both *sensory neurons,* which carry information to the central nervous system, and *motor neurons,* which relay instructions from the central nervous system.

Sensory neurons run between the sense organs and the central nervous system. The sense organs have special sensory neurons called *receptors.* Receptors translate information about the internal or external environment into nerve impulses. These impulses are electrical signals that nerves can carry.

The body has many kinds of sense receptors. Vision receptors in the eyes change light waves into nerve impulses. Similarly, hearing receptors in the ears convert sound waves into nerve impulses. Smell receptors in the nose and taste receptors on the tongue convert chemical information into nerve impulses. Receptors in the skin respond to heat, cold, pressure, and pain. Sense receptors deep within the body provide information on the chemical and physical conditions of the inner body tissues.

Nerve impulses from the sense receptors travel along sensory neurons to the central nervous system. The central nervous system analyses the information and decides what actions, if any, are necessary. If a response is needed, the central nervous system sends out instructions. The motor neurons of the peripheral nervous system carry the instructions from the central nervous system to the appropriate tissues.

The autonomic nervous system is a special part of the peripheral nervous system. It carries messages from the subconscious level of the brain to the internal organs. The autonomic nervous system regulates the automatic functions of the body, such as the beating of the heart and the movement of food through the digestive system.

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Muscular and skeletal systems

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Skeleton
Skull
Spine
Tendon

Digestive system

Alimentary canal
Assimilation
Bile
Colon
Digestive system
Enzyme
Gall bladder
Hunger
Intestine
Liver
Mastication
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Pancreas
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Respiratory system

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Diaphragm
Larynx
Lung
Nose
Pleura
Respiration
Windpipe

Circulatory system

Aorta
Artery
Blood
Capillary
Circulatory system
Corpuscle
Heart
Jugular vein
Lymphatic system
Spleen
Vein

Reproductive system

Baby
Embryo
Embryology
Fertilization
Menstruation
Ovary
Penis
Placenta
Pregnancy
Reproduction
Sex
Sterility
Testicle
Umbilical cord
Uterus

Endocrine system

ACTH
Adrenal gland
Adrenaline
Gland
Hormone
Insulin
Oestrogen
Pancreas
Parathyroid gland
Pineal gland
Pituitary gland
Thyroid gland

Nervous system

Brain
Cerebrospinal fluid
Ear
Eye
Funny bone
Muscle sense
Nervous system
Pain
Perception
Reflex action
Senses
Smell
Solar plexus
Taste
Touch

Other related articles

Abdomen
Anatomy
Appendix
Biological clock
Biology
Bladder
Connective tissue
Disease
Elimination
Growth
Hair
Health
Human being
Kidney
Life
Medicine
Metabolism
Nail
Physical fitness
Physiology
Posture
Prostaglandin
Skin
Throat

Outline

I. What the body is made of
  A. Chemical elements and molecules
  B. Cells and tissues
  C. Organs and organ systems
II. The skin
  A. The epidermis
  B. The dermis
  C. Subcutaneous tissues
III. The skeletal system
IV. The muscular system
  A. Skeletal muscles
  B. Smooth muscles
  C. Cardiac muscle

V. The digestive system
  A. The mouth, oesophagus, and stomach
  B. The small intestine and large intestine
VI. The respiratory system
  A. The air passages
  B. The exchange of carbon dioxide and oxygen
VII. The circulatory system
  A. The heart
  B. The blood vessels
  C. The blood
  D. The lymphatic system
VIII. The urinary system
IX. The reproductive system
X. The endocrine system
XI. The nervous system
  A. The central nervous system
  B. The peripheral nervous system
  C. The autonomic nervous system

Questions

How much of the human body consists of water?
What are the two main jobs of the respiratory system?
How do the salivary glands aid in digestion?
What are *receptors*? What role do they play in the nervous system?
In what ways can the human body be compared to a machine? How does it differ from one?
Why are capillaries important in the circulatory system?
How does the skin help keep the temperature of the body within its normal range?
Why is the pituitary gland called the *master gland*?
What are the four chief kinds of tissues in the human body?
What are the most common chemical elements in the human body?

Human engineering is a technique that applies scientific knowledge of human behaviour to build the various kinds of equipment used by people in their everyday life. It is also called *human factors engineering.* The purpose of human engineering is to make machines as suitable as possible for human use. Human factors engineers try to design machines that match the capabilities and limitations of human beings.

In the early 1900's, engineers discovered that the efficiency of a machine often depends on such human factors as the mood, comfort, and physical condition of the operator. At the same time, sociologists, psychologists, and other scientists studied human behaviour to learn how it affects production. Human engineering grew from these studies. Today, it is applied to the design of computer systems, cars, office equipment, farm and industrial machines, and household devices.

See also **Industrial psychology.**

Human relations is a field of study that deals with group behaviour. Experts in human relations seek to discover the best means of achieving desired goals with a minimum of conflict. Human dignity and respect for the individual are considered basic. Knowledge gained from the social sciences is applied to situations ranging from family relations to international affairs.

Human relations assumes that each individual has certain needs, but that people differ in what they consider important. It also assumes that a person joins a group to get something from it, and that the group in turn expects a contribution from each member.

The basic elements in human relations

Individual needs. Individuals have two kinds of needs: inborn and acquired. *Inborn needs* include food, water, and rest. *Acquired needs* are learned from other people, and may be just as real as inborn needs. For example, a person may skimp on meals (inborn need) in order to meet the payments on a new car (acquired need).

Human relations experts must understand human needs. They must know why people act as they do, how they react to different situations, and what will make them change their minds. Experts study the economic, sociological, psychological, religious, and political motivations which cause various human actions.

Living together. Each individual lives in contact with others because people are social beings. A person's first group usually is his or her immediate family—parents, sisters, and brothers. In most societies, individuals also participate in a large group consisting of other close relatives.

Children first learn to live with their family and playmates. As they grow, their activities may centre on their church, neighbourhood friends, age group at school, or special interests and hobbies. Adults may surround themselves with their own family or belong to a trade union, political party, or a club. Everyone joins temporary groups, such as concert audiences or shopping crowds.

Group conflicts. Every group situation provides opportunities for conflict between the needs of the various members of the group. For example, a building contractor may want to work overtime to finish a job. But the labourers may want to finish on time and go home to their families. In many cases of conflict, satisfying the wants of one person will automatically frustrate the wants of another. If workers go on strike, human relations have broken down. To prevent this, the people involved must find some way to maintain human relations by mutual accommodation.

Most groups have certain formal and informal regulations that minimize misunderstandings and conflicts. Each member of the group is expected to learn and follow these rules. People often learn the norms of the group so thoroughly that they are hardly aware of them. On the basis of accepted rules, group members can predict the behaviour of their fellows. Without accepted norms, people are uncertain about what is expected of them, and the group may easily dissolve.

Conflict between individuals and groups is not always troublesome. Sometimes it increases the unity on each opposing side, reduces tensions, and clarifies the objectives of the individual and the organization.

Leadership is important in keeping the group working together and directing it to act in a certain way. Leadership skill is particularly important when conflicts arise. Leaders must use all their human relations skills to accommodate conflicting interests within their group. A group usually responds to its leader because it respects the leader's wisdom or experience or agrees with his or her opinion.

Human relations in action

Background information. Human relations depends on the contributions of the social sciences. Economists study the relationships of people as they produce and distribute goods and services. Political scientists compile knowledge about the behaviour of people attempting to maintain order. Cultural anthropologists compare ways of living in various societies. Social psychologists concentrate on the ways in which group life moulds the individual's attitudes and personality. Sociologists study the structure of social life and the ways in which groups are formed and function.

Programmes in human relations vary according to the situation. But each programme in human relations must take into account the basic goals of the group and other factors such as the organizational units and the system of control. The *organizational units* include the formal structure and the informal structure within the organization, and any outside influences that might have an effect on orderly group processes. The *system of control* includes all the elements (attitudes, motivations, and organizational units) guiding the actions of people in a certain situation.

Many school systems have introduced programmes of intercultural education, an outstanding example of human relations in action. These programmes try to reduce friction between people of varying backgrounds who live and work in close contact. Human relations programmes also play an important role in many industrial firms. Since the 1940's, many employers have revised their attitudes about employees. They no longer regard an employee as just another pair of "hands," but as a personality with individual wants that the employer must take into account.

Related articles in ***World Book*** include:

Alienation	Minority group
Assimilation	Segregation
Group dynamics	Social psychology
Industrial relations	Social role

Human rights. See **Bill of rights; Civil rights; Slavery** (Views of slavery).

Human Rights, Universal Declaration of, was adopted by the United Nations General Assembly on Dec. 10, 1948. It sets forth the basic civil, economic, political, and social rights and freedoms of every person. The Universal Declaration of Human Rights states that all people are born free and equal in dignity and rights. Its preamble states that the declaration is meant to serve "as a common standard of achievement for all peoples and all nations."

See also **United Nations** (Human rights); **Civil rights** (Civil rights today).

Universal Declaration of Human Rights

Preamble

Whereas recognition of the inherent dignity and of the equal and inalienable rights of all members of the human family is the foundation of freedom, justice and peace in the world,
Whereas disregard and contempt for human rights have resulted in barbarous acts which have outraged the conscience of mankind, and the advent of a world in which human beings shall enjoy freedom of speech and belief and freedom from fear and want has been proclaimed as the highest aspiration of the common people,
Whereas it is essential, if man is not to be compelled to have recourse, as a last resort, to rebellion against tyranny and oppression, that human rights should be protected by the rule of law,
Whereas it is essential to promote the development of friendly relations between nations,
Whereas the peoples of the United Nations have in the Charter reaffirmed their faith in fundamental human rights, in the dignity and worth of the human person and in the equal rights of men and women and have determined to promote social progress and better standards of life in larger freedom,
Whereas Member States have pledged themselves to achieve, in co-operation with the United Nations, the promotion of universal respect for and observance of human rights and fundamental freedoms, Whereas a common understanding of these rights and freedoms is of the greatest importance for the full realization of this pledge,

Now, therefore,
The General Assembly
proclaims this

Universal Declaration of Human Rights as a common standard of achievement for all peoples and all nations, to the end that every individual and every organ of society, keeping this Declaration constantly in mind, shall strive by teaching and education to promote respect for these rights and freedoms and by progressive measures, national and international, to secure their universal and effective recognition and observance, both among the peoples of Member States themselves and among the peoples of territories under their jurisdiction.

Article 1

All human beings are born free and equal in dignity and rights. They are endowed with reason and conscience and should act towards one another in a spirit of brotherhood.

Article 2

Everyone is entitled to all the rights and freedoms set forth in this Declaration, without distinction of any kind, such as race, colour, sex, language, religion, political or other opinion, national or social origin, property, birth or other status. Furthermore, no distinction shall be made on the basis of the political, jurisdictional or international status of the country or territory to which a person belongs, whether it be independent, trust, nonself-governing or under any other limitation of sovereignty.

Article 3

Everyone has the right to life, liberty and security of person.

Article 4

No one shall be held in slavery or servitude; slavery and the slave trade shall be prohibited in all their forms.

Article 5

No one shall be subjected to torture or to cruel, inhuman or degrading treatment or punishment.

Article 6

Everyone has the right to recognition everywhere as a person before the law.

Article 7

All are equal before the law and are entitled without any discrimination to equal protection of the law. All are entitled to equal protection against any discrimination in violation of this Declaration and against any incitement to such discrimination.

Article 8

Everyone has the right to an effective remedy by the competent national tribunals for acts violating the fundamental rights granted him by the constitution or by law.

Article 9

No one shall be subjected to arbitrary arrest, detention or exile.

Article 10

Everyone is entitled in full equality to a fair and public hearing by an independent and impartial tribunal, in the determination of his rights and obligations and of any criminal charge against him.

Article 11

1. Everyone charged with a penal offence has the right to be presumed innocent until proved guilty according to law in a public trial at which he has had all the guarantees necessary for his defence.

2. No one shall be held guilty of any penal offence on account of any act or omission which did not constitute a penal offence, under national or international law, at the time when it was committed. Nor shall a heavier penalty be imposed than the one that was applicable at the time the penal offence was committed.

Article 12

No one shall be subjected to arbitrary interference with his privacy, family, home or correspondence, nor to attacks upon his honour and reputation. Everyone has the right to the protection of the law against such interference or attacks.

Article 13

1. Everyone has the right to freedom of movement and residence within the borders of each state.

2. Everyone has the right to leave any country, including his own, and to return to his country.

Article 14

1. Everyone has the right to seek and to enjoy in other countries asylum from persecution.

2. This right may not be invoked in the case of prosecutions genuinely arising from nonpolitical crimes or from acts contrary to the purposes and principles of the United Nations.

Article 15

1. Everyone has the right to a nationality.

2. No one shall be arbitrarily deprived of his nationality nor denied the right to change his nationality.

Article 16

1. Men and women of full age, without any limitation due to race, nationality or religion, have the right to marry and to found a family. They are entitled to equal rights as to marriage, during marriage and at its dissolution.

2. Marriage shall be entered into only with the free and full consent of the intending spouses.

3. The family is the natural and fundamental group unit of society and is entitled to protection by society and the State.

Article 17

1. Everyone has the right to own property alone as well as in association with others.

2. No one shall be arbitrarily deprived of his property.

Article 18

Everyone has the right to freedom of thought, conscience and religion; this right includes freedom to change his religion or belief, and freedom, either alone or in community with others and in public or private, to manifest his religion or belief in teaching, practice, worship and observance.

Article 19

Everyone has the right to freedom of opinion and expression; this right includes freedom to hold opinions without interference and to seek, receive and impart information and ideas through any media and regardless of frontiers.

Article 20

1. Everyone has the right to freedom of peaceful assembly and association.

2. No one may be compelled to belong to an association.

Article 21

1. Everyone has the right to take part in the government of his country, directly or through freely chosen representatives.

2. Everyone has the right of equal access to public service in his country.

3. The will of the people shall be the basis of the authority of government; this will shall be expressed in periodic and genuine elections which shall be by universal and equal suffrage and shall be held by secret vote or by equivalent free voting procedures.

Article 22

Everyone, as a member of society, has the right to social security and is entitled to realization, through national effort and international co-operation and in accordance with the organization and resources of each State, of the economic, social and cultural rights indispensable for his dignity and the free development of his personality.

Article 23

1. Everyone has the right to work, to free choice of employment, to just and favourable conditions of work and to protection against unemployment.

2. Everyone, without any discrimination, has the right to equal pay for equal work.

3. Everyone who works has the right to just and favourable remuneration ensuring for himself and his family an existence worthy of human dignity, and supplemented, if necessary, by other means of social protection.

4. Everyone has the right to form and to join trade unions for the protection of his interests.

Article 24

Everyone has the right to rest and leisure, including reasonable limitation of working hours and periodic holidays with pay.

Article 25

1. Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control.

2. Motherhood and childhood are entitled to special care and assistance. All children, whether born in or out of wedlock, shall enjoy the same social protection.

Article 26

1. Everyone has the right to education. Education shall be free, at least in the elementary and fundamental stages. Elementary education shall be compulsory. Technical and professional education shall be made generally available and higher education shall be equally accessible to all on the basis of merit.

2. Education shall be directed to the full development of the human personality and to the strengthening of respect for human rights and fundamental freedoms. It shall promote understanding, tolerance and friendship among all nations, racial or religious groups, and shall further the activities of the United Nations for the maintenance of peace.

3. Parents have a prior right to choose the kind of education that shall be given to their children.

Article 27

1. Everyone has the right freely to participate in the cultural life of the community, to enjoy the arts and to share in scientific advancement and its benefits.

2. Everyone has the right to the protection of the moral and material interests resulting from any scientific, literary or artistic production of which he is the author.

Article 28

Everyone is entitled to a social and international order in which the rights and freedoms set forth in this Declaration can be fully realized.

Article 29

1. Everyone has duties to the community in which alone the free and full development of his personality is possible.

2. In the exercise of his rights and freedoms, everyone shall be subject only to such limitations as are determined by law solely for the purpose of securing due recognition and respect for the rights and freedoms of others and of meeting the just requirements of morality, public order and the general welfare in a democratic society.

3. These rights and freedoms may in no case be exercised contrary to the purposes and principles of the United Nations.

Article 30

Nothing in this Declaration may be interpreted as implying for any State, group or person any right to engage in any activity or to perform any act aimed at the destruction of any of the rights and freedoms set forth herein.

Human sacrifice. See **Aztec** (Religion; picture: Human sacrifice); **Maya** (Religion).

Humanism is a way of looking at our world which emphasizes the importance of human beings—their nature and their place in the universe. There have been many varieties of humanism, both religious and nonreligious. But all humanists agree that people are the centre of their study. As the Latin writer Terence said more than 2,000 years ago: "I am a man, and nothing human is foreign to me." Humanism teaches that every person has dignity and worth and therefore should command the respect of every other person.

Although humanism had its roots in the life and thought of ancient Greece and Rome, it flourished as a historical movement in Europe from the 1300's to the 1500's. Its approach to the study of humanity formed the intellectual core of the cultural reawakening called the *Renaissance.* The humanistic attitude toward life has continued to the present day.

The development of humanism

The humanistic movement in the early Renaissance began with the exciting rediscovery of the writings of the classical Greeks and Romans. These writings had either been unknown in Europe since the decline of the Roman Empire, or they had been known in partial and inexact form. The humanists were interested in the ancient classics not only because they were models of literary style, but also because they were guides to the understanding of life.

This understanding was in contrast to the emphasis of many medieval scholars, who taught that life on earth should be despised. Such persons viewed human beings as sinful creatures who should devote their lives to trying to earn a place in heaven.

Humanists rejected this view of the sinful nature of humanity. Their fresh way of looking at life during this *revival of learning* began in Italy in the 1300's and spread to France, Germany, the Netherlands, and England. At its height in the 1500's, humanism was an international fellowship of scholars.

Leading humanists and their influence

Much of modern Western culture comes from humanistic achievements. The spirit and goals of humanism still influence the arts, education, and government.

The arts. Most early humanists were religious. But the main drift of their work led away from the ascetic teachings of the Middle Ages which urged the rejection of this world and its pleasures. Instead, the humanists urged a more robust recognition of the realities of human nature.

Humanistic literature is realistic, critical, and often humorous. The Italian humanist poet Petrarch portrayed the "Laura" of his sonnets as a real woman, not a medieval religious symbol. The brilliant Dutch humanist Erasmus was a priest who tried to find common elements in Greek philosophy and Christian thought. But his great work *The Praise of Folly* was a witty and satiric criticism of kings and churchmen, as well as a recognition of general human error.

England's Geoffrey Chaucer in his *Canterbury Tales* and Italy's Giovanni Boccaccio in his *Decameron* told humorous stories that show a keen understanding of human nature. François Rabelais of France satirized the church, universities, and other institutions in *Gargantua and Pantagruel.* Rabelais combined vast learning and wisdom with rollicking nonsense and earthiness. The English humanist Thomas More was a devout churchman who died a martyr. But *Utopia,* his best-known book, criticized the society of his time. Although all these humanists held high ideals for humanity, they looked at human nature candidly and honestly.

The humanistic attempt to view life both ideally and realistically is also seen in painting and sculpture. Renaissance painters and sculptors continued to create religious art to decorate churches. But they gradually abandoned the stiff, conventional style of medieval art, and developed techniques that emphasized individuality. Humanist painters also turned to nonreligious subjects, such as battles, portraits, and classical themes. In the Netherlands, Pieter Bruegel the Elder painted accurate, vivid scenes of peasant life. Humanist sculptors, including Donatello and Michelangelo, created realistic, richly detailed, and highly individualized statues. All these artists showed men and women as they are, with their varieties of attitudes, gestures, and personalities. Their art also presented people as majestic and worthy of admiration.

Education to the Renaissance humanist meant the training of the "ideal gentleman" or "universal man." Such a person was skilled in many fields of knowledge, including art, science, sports, and politics.

Much later, in the 1800's, the English humanist Matthew Arnold set goals that are probably the best description of the modern humanistic ideal of education. Arnold wanted people to know "the best that has been thought and said in the world." His ideal was the person whose powers were all in balance—who had knowledge, who knew how to live in harmony with others, who appreciated beauty, and who had high standards of moral judgment.

Today, humanistic education centres on the *humanities,* which usually include religion, philosophy, languages, literature, history, and the arts. Together, these subjects have humanistic ideals at their centre. They try to interpret the meaning of life, rather than just describing the physical world or society.

Government. Humanism's opposition to political tyranny in the late 1700's was an important influence in the American and French revolutions. Both the American Declaration of Independence and the French Declaration of the Rights of Man declare the dignity of humanity. They are, therefore, humanistic as well as political documents. Benjamin Franklin, Thomas Jefferson, and other American revolutionary leaders were among the leading humanists of their age.

Humanism today. Many educators and philosophers believe that the greatest challenge to humanism, and indeed a threat to the safety of society, comes from too great an emphasis on science and technology. They realize that scientific achievements have greatly increased our knowledge and power. But they also believe that humanism must teach us how to use this knowledge and power in a moral, human way.

See also **Renaissance** and its list of *Related articles.*

Humanities, The. See **Humanism** (Education).

Humber. See **Humber, River,** and **Humberside.**

Humber, River, in England, flows eastward through Humberside and empties into the North Sea. The River Humber is about 64 kilometres long and from 1.5 to 11 kilometres wide. The Ouse and Trent rivers, two important trade routes, empty into the River Humber. Large steamers can sail up the Humber for a distance of about 32 kilometres from the river's outlet. Hull and Grimsby are important cities on the banks of the River Humber. The port of Hull is a terminus for North Sea ferries. When the Norsemen invaded England during the 800's and 900's, they sailed their boats up the River Humber.

The Humber Bridge, completed in 1981, crosses the river near Hull. It has the longest main span of any suspension bridge in the world. Its main span measures 1,410 metres.

Humberside is a geographical region in northeastern England, lying on both sides of the Humber estuary. It was also an administrative county from 1974 to 1996. Near the estuary is an area of ports and manufacturing industries. This area is dominated by the town of Hull, which is officially called *Kingston upon Hull.* The parts of Humberside away from the Humber estuary are mainly agricultural.

The two halves of the region are linked across the Humber by a bridge that was completed in 1981. The bridge includes the longest single suspension bridge span in the world.

The county of Humberside was created in 1974 from parts of Yorkshire and Lincolnshire. It was abolished as an administrative county with effect from 1996.

People and government

Customs. Celebrations of Plough Monday, on the first Monday after Twelfth Night, were once common in the area. The celebrations have ceased in most areas. But at Haxey, on the Isle of Axholme, people still play the *Haxey Hood Game* on Plough Monday. A hood is thrown up in the air and the villagers, who have been divided into teams, fight for it. Each one of the teams tries to carry the hood to its favourite pub.

Recreation. The main sport is soccer. The region has many amateur teams and three professional teams—Grimsby, Hull, and Scunthorpe—that play in the Football League. Rugby League is popular in Hull and northern Humberside. Cricket is popular. The Yorkshire first class county cricket team plays some of its matches at Hull. Beverley has a horse-racing course, and the town is a centre for racehorse training. Beagling and fox-hunting are popular. Increasing numbers of people take part in water sports on the Humber estuary and on coastal waters.

Local government. The former county of Humberside was divided into nine administrative districts: Beverley, Boothferry, Cleethorpes, East Yorkshire, Glanford, Great Grimsby, Holderness, Kingston upon Hull, and Scunthorpe. With effect from 1996, these were replaced by four unitary authorities, consisting of the following former districts: (1) East Yorkshire, Beverley Holderness, and part of Boothferry; (2) Hull; (3) Glanford, Scunthorpe, and part of Boothferry; and (4) Cleethorpes and Great Grimsby.

Facts in brief about Humberside

Largest towns: Hull, Great Grimsby, Scunthorpe, Cleethorpes, Bridlington, Beverley.

Area: 8,510 km².

Population: *1991 census*—845,200.

Chief products: *Agriculture*—barley, beef and dairy cattle, oats, peas, pigs, potatoes, sheep, sugar beet, turnips, wheat. *Fishing*—cod. *Manufacturing and processing*—aircraft, caravans, chemicals, electrical goods, engineering products, frozen food, iron and steel. *Mining*—chalk, clay, iron ore.

Hull is one of the United Kingdom's leading ports. The port serves as a terminus for North Sea ferries. These ships carry both passengers and motor vehicles to and from Rotterdam, in the Netherlands, and Zeebrugge, on the coast of Belgium.

Economy

Ports and fishing. Humberside's economy depends greatly on the trade of its four ports—Goole, Great Grimsby, Hull, and Immingham. Grimsby and Immingham together form one of the United Kingdom's (UK's) largest ports in terms of tonnage handled. Hull imports foodstuffs and also various raw materials including petroleum and timber.

Immingham Dock, opened in 1912, handles coal, fertilizers, ore, and petroleum. The inland port of Goole, in western Humberside, deals mainly with coal shipments for southern England. Great Grimsby is mainly a fishing port and handles general cargo from Europe.

Manufacturing is concentrated near the Humber estuary. North of the estuary, the main manufactures include chemicals, electrical goods, engineering products, and food. A factory at Brough produces aircraft, and factories at Beverley and Hessle, near Hull, produce caravans.

South of the Humber estuary, the main industry is iron and steel production at Scunthorpe. South Humberside also has a large concentration of chemical and petrochemical factories and oil refineries.

Agriculture. Humberside has good land and is one of the UK's most important farming regions. It is a mainly arable area, with crops including barley, oats, potatoes, sugar beet, turnips, and wheat. Horticulture, particularly pea production, is expanding rapidly. About half the total number of farm animals are cattle, both dairy and beef. The other farm animals are mainly pigs and sheep.

Quarries near Scunthorpe produce iron ore. Other quarries produce chalk and boulder clay, used to make cement.

Tourism. Coastal towns in Humberside that depend on tourism are Bridlington, Cleethorpes, Hornsea, and Withernsea.

Transportation and communication. Humberside has long depended on water transport on the Humber estuary and its linked waterways. Humberside has two motorways, the M62 and M180, linking all the major ports to the national motorway system and to the Humber Bridge. This bridge, which is 1,410 metres long, is the longest suspension bridge in the world.

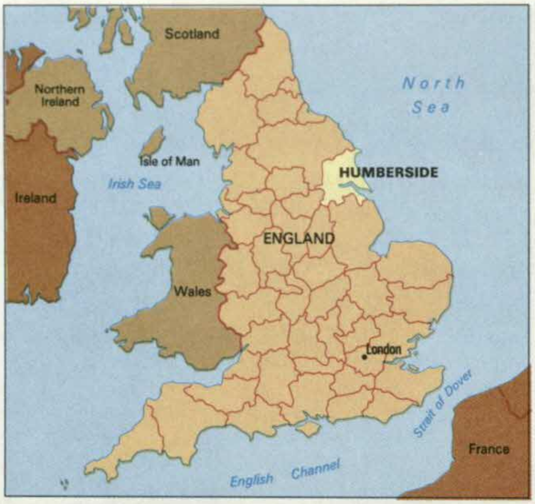
Railway lines run to all the region's main towns. Humberside Airport, between Scunthorpe and Grimsby, is fast growing. It has services to a number of European cities.

Daily newspapers are published in Great Grimsby and Hull. A BBC local station, Radio Humberside, is based in Hull. Viking Radio, an independent local radio station, serves a wide area of the region.

Land

Location and size. Humberside is bounded on its eastern side by the North Sea. It borders on North Yorkshire to the north and west, on South Yorkshire to the southwest, and on Nottinghamshire and Lincolnshire to the south. The region's maximum dimension from north to south and from east to west is about 80 kilometres.

Land features. Humberside is a lowland region. Most of its land lies less than 60 metres above sea level. It has a long coastline. In the extreme north are the impressive chalk cliffs of Flamborough Head. The main hills, also formed of chalk, are the Yorkshire Wolds, west of Hull, and the Lincolnshire Wolds, in southern Humberside. In addition to the Humber estuary, the main rivers are the Ouse, Derwent, Trent, and Hull.



Humberside is a county in northeastern England lying on both sides of the Humber estuary.

Climate. Humberside has relatively little rain. The average annual rainfall is about 580 millimetres near the coast and about 800 millimetres on the higher parts of the Wolds. The average midwinter temperature in Humberside is about 5° C and the average midsummer temperature is about 17° C.

History

Humberside is rich in prehistoric remains. On the Wolds are a number of *long barrows* (burial mounds) from the New Stone Age. During the Bronze Age, settlers from the Rhineland on the European mainland settled in the Humberside area. They left many *round barrows.* During the Iron Age, Humberside was the home of the *Parisii,* who left remains of chariot burials.

The Romans laid a road from Lincoln to York, crossing Humberside. They built a town, *Petuaria,* at Brough. Later, Anglo-Saxons and Vikings invaded the area. The last great battle between the Vikings and the Anglo-Saxons occurred at Stamford Bridge just before the Battle of Hastings.

In medieval times, towns such as Hedon and Hull grew up along the Humber. Many churches were built. In 1536, the Pilgrimage of Grace, a revolt against the Reformation, took place in Humberside. In the 1700's and 1800's, agricultural improvements and new industries caused the economy to expand.

Famous Humberside people include Andrew Marvell, poet and politician, born at Winestead; John Wesley, founder of Methodism, born at Epworth; and William Wilberforce, opponent of slavery, born in Hull.

Related articles in ***World Book*** include:

Bronze Age
Grimsby, Great
Hull
Iron Age
Marvell, Andrew
Pilgrimage of Grace
Scunthorpe
Stone Age
Wesley, John
Wilberforce, William

Humboldt, Baron von (1769-1859), was a German scientist and geographer. He helped found modern geography and pioneered in plant geography and climatology. Humboldt drew the first map with *isothermal* lines (lines connecting points of the same temperature). He travelled extensively in the Spanish territories of America. In his famous five-volume work, *Cosmos* (1845-1862), Humboldt tried to describe fully the physical universe.

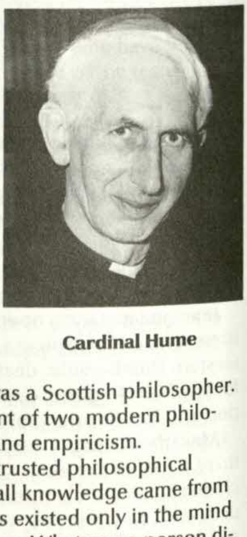
Alexander von Humboldt was born in Berlin on Sept. 14, 1769. He studied geology, biology, and political science at the University of Göttingen, and mining and metallurgy at the School of Mines in Freiburg. From 1792 to 1797, he was a mine assessor in Prussia. Then he resigned to study nature, a strong interest since his childhood. Humboldt explored Mexico, Central America, and South America from 1799 to 1804. He lived for the next 20 years in Paris, which was then a centre of geographical learning.

Humboldt spent most of his remaining years in Berlin. At the University of Berlin, he gave the lectures on which he based *Cosmos.* He made his most important later voyages for the Russian czar, who sent him to the Ural Mountains and Central Asia in 1829 to report on mineral resources.

See also **Geology** (The rock dispute).

Humboldt Current. See **Peru Current.**

Hume, Basil Cardinal (1923-   ), a British Roman Catholic teacher and theologian, became archbishop of Westminster, London, in 1976. George Basil Hume was born in Newcastle upon Tyne, England. Hume was educated at Ampleforth College, near York, at St. Benet's Hall, Oxford, and at the University of Fribourg, Switzerland. Ordained in 1950, Hume returned to Ampleforth as a teacher and won a high reputation for his work. He became abbot of Ampleforth in 1963. In 1976, the Pope made Hume a cardinal.



Cardinal Hume

Hume, David (1711-1776), was a Scottish philosopher. He influenced the development of two modern philosophical schools, scepticism and empiricism.

His philosophy. Hume distrusted philosophical speculation. He believed that all knowledge came from experience and all experiences existed only in the mind as individual units of experience. Whatever a person directly experienced was nothing more than the contents of his or her own consciousness, or mind. Hume believed that a world existed outside of human consciousness, but he did not think this belief could be proved. See **Scepticism; Empiricism.**

Hume called lively and forceful units of experience *perceptions* and less lively and forceful units *beliefs* or *thoughts.* Words and concepts were meaningful for a person only if they related directly to these units of experience. Each unit of experience was separate and distinct from all other units, though the units were usually experienced as being connected.

According to Hume, three principles connected associated ideas with each other: (1) *resemblance,* (2) *contiguity,* and (3) *cause and effect.* In resemblance, if two units of experience resembled each other, thought of one led to thought of the other. In contiguity, if two units adjoined each other, thought of one provoked thought of the other. In cause and effect, if one unit constantly preceded another, thought of the first resulted in thought of the second.

Hume was famous for his attack on the principle of *causality.* This principle states that nothing can happen or exist without a cause. Hume believed that although one *event* (set of impressions) always preceded another, this did not prove that the first event caused the second. The constant conjunction of two events, he said, built up the expectation that the second event would take place after the first. But this was nothing more than a strong belief or habit of mind taught by experience. One could never prove there were causal connections among impressions.

Hume, an agnostic, argued that the existence of God could not be proved. He said that even granting God's existence, nothing could be absolutely known about His nature. On the other hand, Hume believed that God's existence could not be disproved either.

Hume based his theory of morality on experience, rejecting the view that reason could distinguish virtue from vice. He examined the circumstances in which people spoke of morality. He concluded that virtuous characteristics in people were those that were agreeable or useful to them. Hume claimed that all people possessed the feeling of *benevolence* (good will) and that this feeling was the basis of moral judgments.

His life. Hume was born in Edinburgh and spent most of his life writing. Occasionally, he served on diplomatic missions in France and other countries. His major work, *A Treatise of Human Nature* (1739, 1740), attracted little attention when it was published. But Hume's fame grew, especially in France, after he published more works on philosophy, religion, and history. These works included *Philosophical Essays Concerning Human Understanding* (1748) and *An Enquiry Concerning the Principles of Morals* (1751). Hume's *History of Great Britain* (1754, 1756) and *History of England* (1759, 1762) rank among the first important histories of that country.

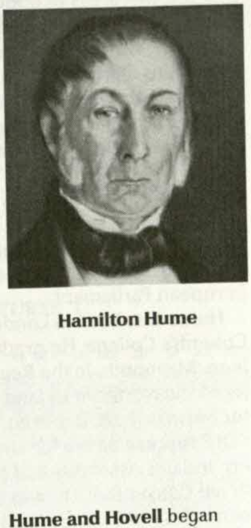
See also **Philosophy** (Modern philosophy).

Hume, Hamilton (1797-1873), the first Australian-born explorer, opened up an overland route from Sydney to Port Phillip, the present site of Melbourne, Australia.

Hume was born near Parramatta, New South Wales, and was educated by his mother. His father, Andrew Hume, was superintendent of convicts in New South Wales.

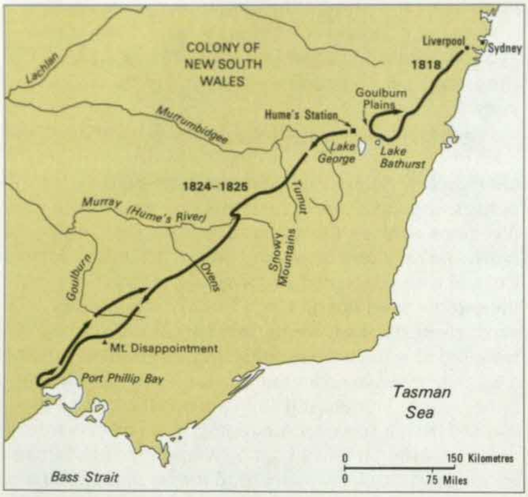
Hume made his celebrated journey to Port Phillip and back in 1824 and 1825. A former sea captain, William Hilton Hovell, accompanied Hume and shared the expenses. The government's contribution was limited to a few items, such as a tent, tarpaulin, pack saddles, firearms, and ammunition. Taking horses, bullocks, and two carts, and accompanied by six of their convict servants, the explorers set out on Oct. 17, 1824, from Hume's property near Lake George. To measure the distance travelled they used a *perambulator,* a device resembling a wheelbarrow. In order to cross the flooded Murrumbidgee River, Hume used an ingenious method he had learned from a surveyor. He removed the wheels from a cart, converting it into a boat by wrapping it in a tarpaulin. He used it to ferry supplies to the far bank. Soon afterward, they abandoned their carts and, moving south, noted the snow-capped peaks of the Australian Alps. Later they came to a broad stream, which Hovell named *Hume's River.* Hovell marked a tree beside the Murray River at Albury. The tree is now a memorial. The Hume Reservoir now covers the spot where the explorers crossed the river.

Finding the Mitta Mitta in flood, they made a tarpaulin boat with a frame of light bush timber. They crossed the Kiewa River over a fallen tree. The explorers named the Ovens River in honour of Major John Ovens and sighted and named Mount Buffalo. On December 3, they crossed another river, naming it after Major Frederick Goulburn. The explorers climbed a mountain, but the heavy scrub blocked them, and they were forced to go westward. The peak they climbed, Mount Disappointment, is located near Melbourne.



Hamilton Hume

Hume and Hovell began their journey south with carts to carry their provisions. They followed the route now known as the Hume Highway, which links Sydney and Melbourne.



Hamilton Hume discovered Lake Bathurst in 1818. In 1824, he left Lake George with William Hovell, crossed the river later called the Murray, and reached Port Phillip Bay.

Eventually, on December 16, Hume's party reached the western shore of a large bay. Aborigines told them the locality was called *Geelong.*

Their return journey was uneventful. Thanks to Hume's bushcraft, they made many short cuts and arrived back at Lake George on Jan. 18, 1825. Hume discovered vast areas of good farmland. Governor Thomas Brisbane granted him land in recognition of his work.

In 1827, Hume traced a new route over the Blue Mountains, earning himself a further grant of land. In 1828, he went with Charles Sturt on the expedition that discovered the Darling River. After this expedition, Hume was granted land on the Yass Plains, New South Wales. He settled there as his health was failing. In his last years, Hume served as a magistrate.

Hume, John (1937-), is the leader of the Social Democratic and Labour Party (SDLP) in Northern Ireland. He is a member of both the British Parliament and the European Parliament.

Hume was born in Londonderry and educated at St. Columb's College. He graduated from St. Patrick's College, Maynooth, in the Republic of Ireland. Hume entered the Northern Ireland Parliament as the member for Foyle in 1969. Between 1973 and 1976, he was the SDLP representative for Londonderry in both the Northern Ireland Assembly and the Northern Ireland Constitutional Convention. He was the province's minister for commerce in 1974. Hume became a member of the European Parliament (MEP) in June 1979. He succeeded Gerry Fitt as leader of the SDLP the following November. Hume was elected to the British Parliament at Westminster in 1983.

Hume Reservoir stands on the Murray River, in Australia, on the border of New South Wales and Victoria. The dam is 51 metres high. The reservoir holds about 3,000 million cubic metres of water. The original dam was built in 1926. Engineers increased its capacity in 1962.

Humerus. See Arm.

Humidifier is a device that increases the amount of moisture in indoor air or a stream of air. It operates by allowing water to evaporate from a pan or a wetted surface, or by circulating air through an air-washer compartment that contains moisture.

Humidifiers are used in industry to create an atmosphere suitable for testing or processing certain materials. In homes, humidifiers help reduce static electricity and prevent wood structures and furniture from becoming brittle.

Many people use humidifiers in the winter to help them feel more comfortable. Heated air is very dry and can irritate nasal passages. Humidifiers help reduce such irritation. They also slow the evaporation of moisture from people's skin. The cooling effect of evaporation is thereby reduced, making people feel warmer at lower temperatures.

See also **Air conditioning** (Controlling the moisture); **Dehumidifier; Humidity.**

Humidity is a term that describes the amount of water vapour in the air. The humidity varies according to the temperature and pressure of the air. The warmer the air is, the more water vapour it can hold. When the air contains as much water vapour as it can hold at a certain temperature and pressure, the air is said to be *saturated* with water vapour.

The amount of water vapour in the air compared to the amount the air can hold at saturation is called *relative humidity.* If the air contains only half of the water vapour it can hold, the relative humidity is 50 per cent. In clouds and fog, the air is saturated and the relative humidity is 100 per cent. The lower air over oceans is almost saturated and the relative humidity is close to 100 per cent. In the Sahara and other subtropical deserts, the relative humidity may be as low as 10 per cent.

The relative humidity of an area may vary greatly during the day, even though the amount of water vapour in the air remains the same. In such cases, the relative humidity changes as the temperature rises and falls. For example, the relative humidity may be high in the morning, when the temperature is low and the air cannot hold a great deal more than its present water vapour. But as the temperature rises during the day, the air can hold more water vapour and the relative humidity therefore becomes lower.

As air at a fixed pressure and with a constant amount of water vapour is cooled, it will reach a temperature where it becomes saturated. This temperature is called the *dew point.* If the temperature is lowered further, water vapour will begin to condense and form clouds, fog, or dew. The further the temperature of the air decreases toward its dew point, the higher the relative humidity will be.

Humidity affects our comfort and health. When the temperature and the relative humidity are high, most people feel uncomfortable and "sticky" because their perspiration does not evaporate easily. Many people use air conditioners and dehumidifiers in the summer to take water vapour out of the air. In winter, the heated air in buildings is dry and the relative humidity indoors may be very low. These conditions can cause drying of nasal passages and other health problems. As a result, people often use humidifiers in winter to put water vapour into the air.

Related articles in *World Book* include:

Air conditioning
Cloud
Dehumidifier
Dew
Evaporation
Fog
Humidifier
Hygrometer
Rain
Temperature-humidity index
Weather

Hummingbird is a family of birds that contains the smallest bird in the world. Hummingbirds live only in the Western Hemisphere, including many islands of the Caribbean. They are found wherever there are nectar-producing flowers. More than 300 species are known. Hummingbirds get their names from the humming sound made by their wings, which move 60 to 70 times a second in the smallest species. In flight, because of the speed of the wing-beat, the hummingbird's wings are visible only as a blur.

Some hummingbirds are very widely distributed. The tropical black-throated mango, for instance, is found in all areas from Panama to Paraguay. But the greatest concentration of species occurs within ten degrees latitude of the equator. Most species are resident all year round, but some hummingbirds migrate. In California, Anna's hummingbird escapes the heat and drought of the lowland summer by moving into the mountains.

Size. The smallest of the hummingbirds are no larger than bumble bees. Only a few are more than 15 centimetres long. The largest is the *giant hummingbird,* a native of the Andes Mountains of South America. It is about 21 centimetres long, including the bill. The smallest is the *bee hummingbird,* a native of Cuba. It is about 5 centimetres long.

Habits. Some members of the hummingbird family are among the most brightly coloured birds in the world. They have glittering patches of emerald green, deep violet, fiery red, and glowing orange. They fly quickly and can dart upward, downward, backward, or forward with remarkable speed. Their long, slender bills are especially suited for sucking nectar from flowers, even the deep-throated or trumpet-shaped flowers such as the honeysuckle and trumpet flower. The tongue of the hummingbird is also a useful tool for obtaining food from places difficult to reach. It is shaped like a long tube through which the birds suck the flower nectar. The bird hovers forward while inserting its bill and backward as it withdraws it. The hummingbird's ability to hover forward and backward in this way is unique among birds.

Food. Insects form an important part of the hummingbird's diet. The bird often finds insects inside the flowers, or seizes them while it hovers. Sometimes it steals insects from spider webs. The hummingbird also uses the threads from the spider web to build its cottony nest.

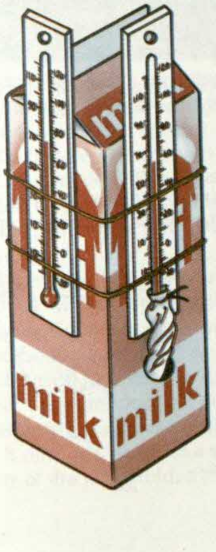
Because hummingbirds are so tiny, they need plenty of food to maintain body-heat. Often they eat more than half their body-weight in a day. If hummingbirds need to conserve energy, they go into a state of torpor at night: the body temperature, usually about 41° C, falls to the temperature of the surrounding air.

Breeding behaviour. Hummingbirds breed according to the flowering times of the plants they visit for nectar. This means that, in temperate areas, they breed in spring. In arid zones they may wait to breed until the rainy season. Mating takes place at singing grounds, or *leks,* where the males congregate to entice the females. The female builds the nest and attends the brood single-handed. Usually two eggs are laid.

Scientific classification. Hummingbirds make up the family Trochilidae. The black-throated mango is *Anthracothorax nigricollis;* Anna's hummingbird is *Calypte anna;* the giant hummingbird is *Patagona gigas;* and the bee hummingbird, *Calypte helenae.*

See also **Bird** (picture); **Photography** (picture).

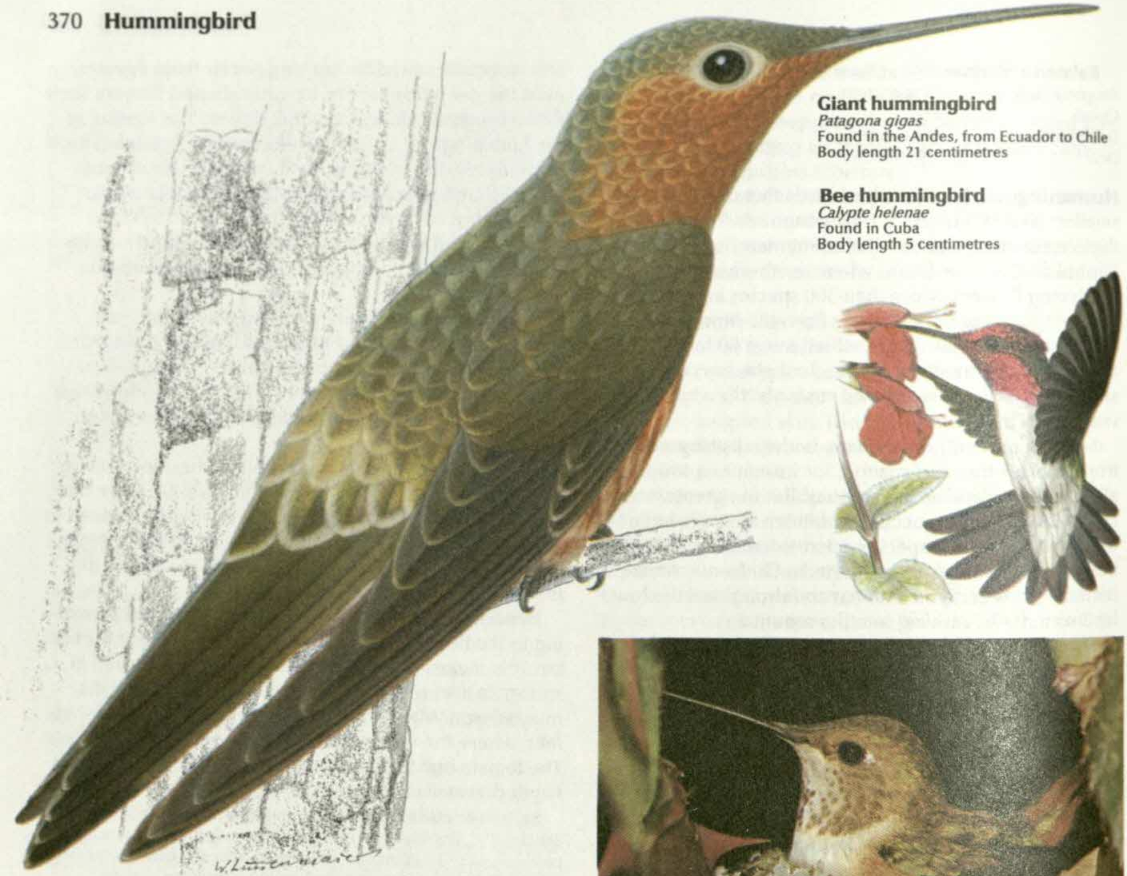
To make a hygrometer, cut a hole about 7 centimetres from the bottom of an empty milk carton and fill the carton with water up to the opening. Fasten two thermometers to the carton, one with the bulb just above the hole. Wrap cloth around this bulb and push it through the hole into the water.



To determine relative humidity, allow the hygrometer to stand for 15 minutes in a breeze away from direct sunlight. Read both thermometers and use the temperatures to find the humidity on the chart, *below.* Read across from the dry-bulb readings. Read downward from the wet-bulb readings. For example, if the dry-bulb thermometer reads 20° C and the wet-bulb thermometer reads 13° C, the relative humidity is 44 per cent.

WET-BULB TEMPERATURES °C

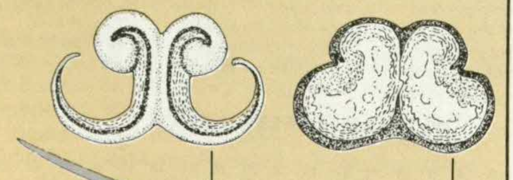
DRY-BULB TEMPERATURES °C	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
10	14	24	34	44	54	65	76	88														
12	3	11	20	29	38	48	57	68	78	89												
14		2	9	17	25	33	42	51	60	70	79	90										
16				8	15	22	30	37	46	54	62	71	81	90								
18						13	20	27	34	41	49	56	65	73	82	91						
20								13	24	30	37	44	51	59	66	74	83	91				
22										22	28	34	40	47	54	61	68	76	83	92		
24												26	31	37	43	49	56	62	69	77	84	92

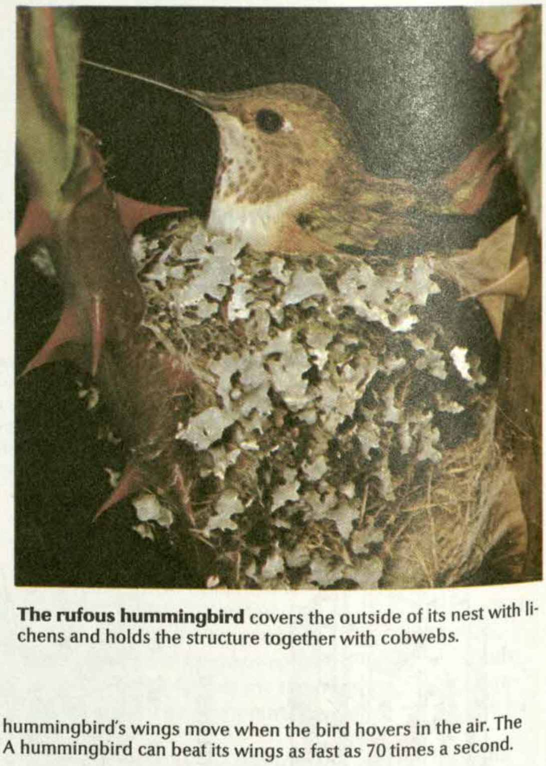


Giant hummingbird
Patagona gigas
Found in the Andes, from Ecuador to Chile
Body length 21 centimetres

Bee hummingbird
Calypte helenae
Found in Cuba
Body length 5 centimetres

The end of the hummingbird's tongue is forked. The edges of the two parts curl together and form a double trough through which nectar is taken into the mouth.

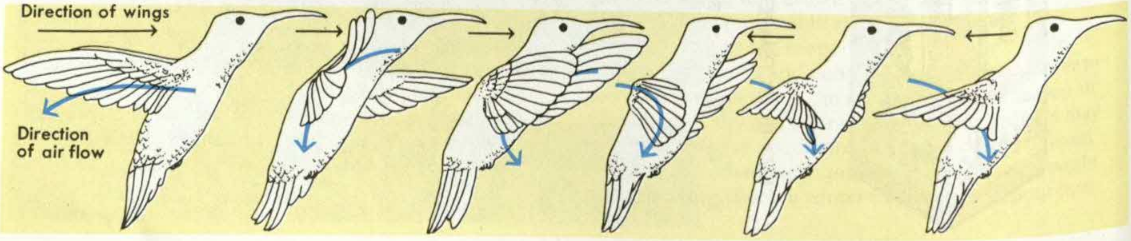




The rufous hummingbird covers the outside of its nest with lichens and holds the structure together with cobwebs.

How a hummingbird hovers

The diagram below shows how a hummingbird's wings move when the bird hovers in the air. The pictures represent one wingbeat. A hummingbird can beat its wings as fast as 70 times a second.



Hummingbird moth. See Hawk moth.

Humour is any body fluid that is carried in the blood to act on a gland or other tissue. Certain fluids in the eye are called the aqueous and vitreous humours. The ancient Greeks believed that the body was made up of four humours: blood, phlegm, yellow bile, and black bile. A person was believed to be healthy when the body's four humours were properly mixed.

Humour. No one knows exactly why we laugh, or why anything that is funny should cause us to make such a peculiar noise. It would be just as logical to stick our thumbs in our ears and wiggle our fingers as it is to giggle or bellow or howl with laughter. But when something strikes us as funny, our diaphragm flutters up and down, and we laugh.

The urge to laugh appears very early. Babies smile, then coo, and finally chuckle when pleased. If certain parts of the body are tickled with the fingers, laughter is produced in babies as well as in many adults. But by the time children attend school, they also laugh at things they hear and see.

Stories are among the most popular forms of humor. As a rule, a story is considered inferior if it makes some person blush with embarrassment, if it makes something sacred appear common, if it makes a person's weakness the cause for laughter, if it has to have profanity or vulgarity to be funny, or if everyone cannot join in the enjoyment of the joke.

The humour of situation

If a man meets a woman on the street, tips his hat to her, and a pigeon flies out from beneath it, most of the people who see it would laugh. This is called the humour of the *unexpected happening.*

Another kind of situation humour is the *incongruous* (putting together unrelated things). Boys and girls see dogs every day and think nothing of them. But if a dog enters a classroom, everyone laughs. The dog does not belong there, and the situation is incongruous.

The humour of words

Situation humour need not be described in words. By far the greatest amount of humour is told rather than seen. Certain words are funny in their very sounds, like *bobble* and *squirt.* Sometimes people get mixed up in saying their words, and instead of saying "people think" they might say "thinkle peep."

Puns, or double meanings, furnish us with much of our humour. Puns are *plays on words,* in which one word is said when another one is meant. For example, it is said that Ben Jonson was asked by a friend to make a pun. Ben replied, "Pun what subject?" for "Upon what subject?" The friend laughed at this pun, but said, "Oh, the king." Ben then said, "But the king is not a subject. He is the king."

Hyperbole is simply exaggeration. Sometimes it includes a twisting or distortion of the truth for the sake of humour. Common expressions of everyday life are often hyperboles. If a woman says "It's raining cats and dogs" she is using hyperbole. And if she is answered with "I know. I just stepped in a poodle," she hears a pun.

Repetition is also a popular way of gaining laughter, but it does not produce a very high grade of humour. In many of the jokes told, a thing happens twice in exactly the same way. But the third time it happens differently, and the point of the story is revealed.

A man's car was stuck in the mud one rainy day. He walked to the nearest farmhouse to telephone for help. The farmer had no telephone, but said the farm down the road had one. Muttering angrily, the man plodded on through the rain. The second farmer's telephone was out of order, but this farmer said another farm still farther down the road had one. The motorist was near to exploding point when he reached the third farm. As the farmer shuffled to the door, the motorist yelled, "You idiot! I wouldn't use your phone even if you had one!"

Comparison often gives rise to humour. It is almost the same as the incongruous situation. "My head's as clear as a bell. In fact, I hear it ringing" shows comparison.

The types of humour

Humour of words takes many forms. It can be gentle and kind, or it can be harsh and biting. There is no exact distinction between these various types of humour.

Wit differs from most humour in being purely intellectual, rather than relying on incongruities that come up naturally in many situations. Most humour produces a smile, but wit usually causes people to break out in sudden laughter.

Satire presents the weaknesses of humanity and makes fun of them. Usually, satire attempts to cure the foolishness by making people laugh at it.

Sarcasm is much more brutal than satire. It often takes the form of a biting speech. For example, if one woman says to another, "That's a lovely dress, dear. Pity they didn't have your size," the woman is sarcastic.

Irony implies the opposite of what is apparently being stated. Irony may begin as a compliment or a simple statement, but it conceals a sting in the remark. It is usually expressed by a tone of voice, and is often an understatement.

Farce, slapstick, and buffoonery involve such pranks as throwing custard pies or pushing unsuspecting persons into swimming pools.

Parody and burlesque change the wording of a well-known story or song to produce comic results.

Mimicry imitates another person's habits, gestures, or speech for comic effect.

Related articles in ***World Book*** include:

Humorists

Allen, Woody
Beaumarchais, Pierre A.
Chaplin, Charlie
Goldsmith, Oliver
Hogan, Paul
Humphries, Barry
Jerome, Jerome K.
Leacock, Stephen B.
Munro, Hector H.
Nash, Ogden
Rabelais, François
Rogers, Will
Shaw, George Bernard
Thurber, James
Twain, Mark
Wilde, Oscar
Wodehouse, P.G.

Other related articles

Burlesque
Comedy
Hyperbole
Irony
Parody
Pun
Satire

Humpback. See Hunchback.

Humperdinck, Engelbert (1854-1921), was a German composer. He composed mainly vocal works, and his music shows the influence of the German folk song. Humperdinck gained immediate success for his children's opera *Hansel and Gretel* (1893), his best-known composition. He wrote the music for a text his sister adapted from a Grimm's fairy tale. His other important work is the opera *The Royal Children* (1910), which also had a fairy-tale theme. Humperdinck wrote a number of choral works and more than 60 songs. He also wrote incidental music for plays, including four plays by William Shakespeare.

In 1880, Humperdinck met the German composer Richard Wagner. He served as Wagner's assistant and helped him score and prepare for the first performance the opera *Parsifal* (1882). During his career, Humperdinck also taught music in a number of conservatories. He was born in Sieburg, near Bonn.

Humphries, Barry (1934-), an Australian writer, actor, and satirist, created the roles of Dame Edna Everage, the housewife superstar; Sir Les Patterson, the beer-swilling, Australian cultural attaché; and Barry McKenzie, an Australian innocent abroad. Humphries began his popular one-man shows in Australia and England in the 1950's. He also wrote several books. He was born in Melbourne and was educated at Melbourne Grammar School and Melbourne University.

Humus is a dark brown substance found in soil. It is formed when roots, plants, and the dead bodies of small animals decay. The decay is caused by the action of microscopic living beings called *bacteria* and *fungi*. The amount of humus in soil affects the soil's texture and its ability to hold moisture and to supply necessary food. A good mixture of humus generally increases the size and quality of a crop.

Humus is soft and spongy. It fills the spaces between the mineral grains of the soil, and enables the plant roots to send out tiny hairs through which they absorb water and food. Humus also holds water and reduces the problem of water running off and *eroding* (wearing away) the soil.

See also **Sewage** (Rural sewerage systems).

Hun was a member of the wandering and warlike people that invaded the Roman Empire in the A.D. 400's. Under the direction of Attila, their greatest leader, the Huns nearly destroyed the Roman empires of the east and west.

The Huns moved westward across the Volga about A.D. 350 and defeated the Alani people. Then they conquered and drove out the Goths. With their subject peoples, the Huns invaded Gaul under Attila.

They were finally halted in 451, and they later failed in another attempt at invasion. After the death of Attila (453), the subject peoples revolted and defeated the Huns. The Huns were later absorbed into the various racial strains of Europe.

See also **Attila; Goths.**

Hunchback is a nonmedical term for the forward bending of the spine. Doctors use the term *kyphosis* to describe this condition. A severe case of kyphosis results in a rounded or sharp prominence of the upper part of the back. Because this part of the back sticks out like a big hump, the condition is sometimes called *humpback*. Kyphosis is caused by any condition that deforms the bones of the upper part of the spine so that the person is bent forward. Diseases that cause kyphosis include tuberculosis, syphilis, and rheumatoid arthritis. Fractured spinal bones also may cause a hump in the back.

Hundred Years' War (1337-1453) extended over the reigns of five English and five French kings who fought for control of France. This struggle between England and France actually consisted of a succession of wars broken by truces and treaties. The English loss of Normandy in France in 1204 developed as the basic cause of the war. The war had several contributing causes. Efforts of French kings to control the English-held province of Gascony in southwest France angered the English. The French supported the Scots against England, and the French attempted to control Flanders and the English wool trade there. English and French sailors and fishermen quarrelled over rights in the English Channel. Edward III of England, whose mother was the sister of three French kings, formally claimed the throne of France in 1337 (see **Salic Law**). He landed an army in Normandy to begin the Hundred Years' War.

In the fighting that followed, the English won most of the battles. But the French won the war. English resources in manpower, supplies, and wealth were about a third as great as those of the French. Several events hindered the course of the war. These included peasant rebellions, pillaging in France by unemployed soldiers, the *Black Death,* or bubonic plague, in the two countries, and a peasants' revolt in England in 1381. The war weakened the powers of the nobility, and strengthened centralized government in both countries. It also marked the decline of feudalism, the rise of French unity, the development of new military tactics, and the growth of English sea power.

English archers and infantry won the war's greatest victory in the Battle of Crécy (1346). The English also won the Battle of Poitiers (1356). The Treaty of Brétigny in 1360 began a brief period of peace. But Henry V of England renewed the fighting, and emerged triumphant at the Battle of Agincourt (1415). The Treaty of Troyes in 1420 made Henry V heir to the French crown.

After Henry V died in 1422, the French disputed the English claim to the throne, and war flared again. By 1428 the English had swept through northern France and laid siege to Orléans. Joan of Arc led a French army in raising the siege in 1429. She became a prisoner of the English, who later burned her as a witch. The French continued to win battles. By the time the war ended in 1453, England had lost all its territory on the continent of Europe, except for Calais. The French gained possession of Calais in 1558.

Related articles in ***World Book*** include:

Agincourt, Battle of
Crécy, Battle of
England (The Hundred Years' War)
Froissart, Jean
Henry (V) of England
Joan of Arc, Saint (Joan sees the king)
Poitiers, Battle of

Hundredweight is a unit of weight. The English hundredweight of 112 pounds is called a *long hundredweight*. In the United States it is equal to 100 pounds. This is called a *short hundredweight*. The *metric hundredweight* is equal to 50 kilograms. The long hundredweight contains 50.8 kilograms and the short hundredweight contains 45.36 kilograms.

Hungarian pointer. See **Vizsla.**

Hungary has changed greatly since the mid-1900's, when it was a largely agricultural nation. Today, many Hungarians work in industry, and about two-thirds of them live in urban areas, such as Budapest, *left.* Farmers, *right,* make up less than a quarter of Hungary's work force.

Hungary

Hungary is a small, landlocked country in central Europe. Great economic and social changes have occurred in Hungary since the late 1940's. Before that time, most of the country's income came from agriculture, and the majority of Hungarians lived in rural areas and worked on farms. But Hungary's economy has become increasingly industrialized. Today, manufacturing and other industries contribute more to the national income than does farming. More Hungarians now work in industry than on farms, and about two-thirds of the people live in cities and towns. Almost a fifth of Hungary's people live in Budapest, the country's capital and largest city.

As Hungary has become more industrialized, modern city ways of life have replaced many of the country's old rural customs. But Hungarians still love the highly seasoned foods, excellent wines, and lively folk music for which they have long been famous.

Most of eastern Hungary is nearly flat, but the western part has hills and low mountains. The chief natural resources include fertile soil and a favourable climate for farming.

Hungary was a large, independent, and powerful kingdom until the late 1400's. From the early 1500's to the late 1600's, the Ottoman Turks ruled much of Hungary. The country then became part of a huge empire ruled by the Austrian branch of the Habsburgs, a powerful European *dynasty* (line of rulers). The empire of the Habsburgs collapsed after World War I ended in 1918. Hungary then lost about two-thirds of its land but regained its independence.

In the late 1940's, Hungarian Communists gained control of the country's government. They adopted a constitution similar to that of the Soviet Union and began to restrict the freedom of the people and to manage the entire economy. In 1956, the Hungarian people revolted against their Communist government and Soviet domination. But Soviet troops quickly crushed the revolution. However, opposition to Communist control continued. Gradually, restrictions on the freedom of the people were eased. In the late 1980's, the Soviet Union made reforms toward giving its people more freedom. The reform movement in Hungary then gained further strength. In 1989, the Hungarian Communist Party—officially called the Hungarian Socialist Workers' Party—voted to end its control over the government and increased freedoms further. Hungary's first multiparty elections since 1949 were held in 1990. Non-Communist parties held power until 1994.

Facts in brief about Hungary

Capital: Budapest.
Official language: Magyar (Hungarian).
Official name: Magyar Köztársaság (Republic of Hungary).
Area: 93,032 km². *Greatest distances*—east-west, 502 km; north-south, 311 km.
Elevation: *Highest*—Mount Kékes, 1,015 m above sea level. *Lowest*—near Szeged, 79 m above sea level.
Population: *Estimated 1996 population*—10,518,000; density, 111 people per km²; distribution, 65 per cent urban, 35 per cent rural. *1990 census*—10,374,823. *Estimated 2001 population*—10,518,000.
Chief products: *Agriculture*—wheat, maize, pigs, milk, potatoes, grapes, chickens and eggs, sugar beet. *Manufacturing*—steel, buses and railway equipment, electrical and electronic goods, food products, pharmaceuticals, medical and scientific equipment, textiles. *Mining*—bauxite.
Money: *Currency unit*—forint. One forint = 100 fillér.

Government

After the Communists took control of Hungary, they made the Communist Party the country's only legal political party. Only a small percentage of Hungary's people belonged to the party. However, Communist Party leaders held important positions at all levels of government and in major nongovernmental organizations. The general secretary, the head of the Communist Party, was the most powerful leader in Hungary.

In 1988, the Communist Party's power and authority began to erode. Public pressure forced the party's leaders to agree to allow other political parties to form. In October 1989, the Communist Party ended its monopoly on power in the country. It declared itself socialist and renamed itself the Hungarian Socialist Party. Later that month, Hungary's National Assembly changed the 1949 Constitution to create a multiparty democracy with broad freedoms for the people. Non-Communist parties were officially legalized.

In 1990, multiparty elections were held. The Hungarian Democratic Forum—a non-Communist party—won a majority of seats in the parliament and became the leading political party. But in elections held in 1994, the Hungarian Socialist Party won a majority of seats.

Hungary's other non-Communist parties include the Alliance of Free Democrats, the Independent Smallholders Party, and the Social Democratic Party. Some Communists opposed their party's action of becoming a socialist party in 1989. They formed a new Communist organization and kept the old name of the Hungarian Socialist Workers' Party.

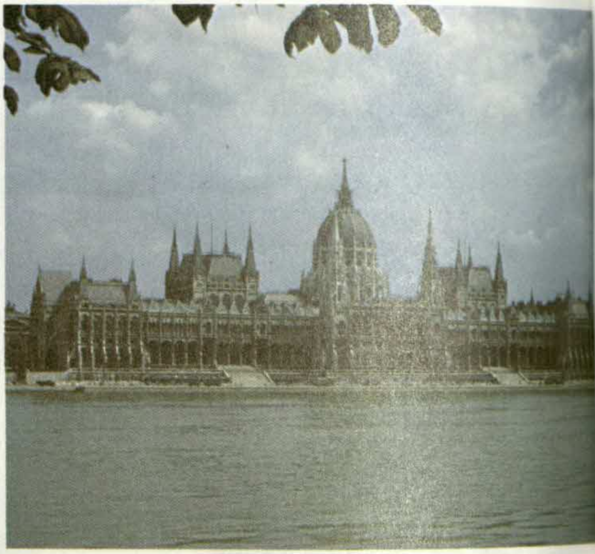
National government. Hungary has a one-house parliament, called the National Assembly. Voters elect the parliament's members to four-year terms. The Assembly formally enacts all laws. In the past, the National Assembly elected 21 of its members to a Presidential Council, which served as the parliament between Assembly sessions. The chairman of the Presidential Council was Hungary's head of state. In 1989, changes in Hungary's Constitution abolished the Presidential Council and created a new office of president. The president is the head of state. The National Assembly elects the president to a four-year term. The president's duties include acting as commander in chief of the armed forces, authorizing elections, and serving as the parliament between Assembly sessions.

The Assembly appoints a Council of Ministers. Members of this group head the various government departments. The chairman of the council serves as Hungary's head of government, or prime minister.

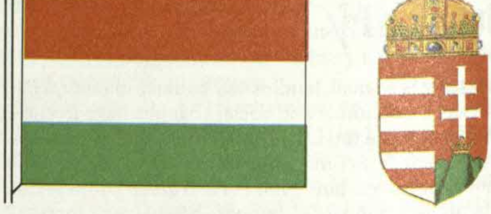
Local government. Hungary is divided into 19 counties and 6 cities, including Budapest, that rank as counties. A council governs each county or city of county rank, as well as each town and rural community. Council members are elected by the people to four-year terms.

Courts. The Supreme Court is Hungary's highest court. Other courts include county, district, labour affairs, and military courts.

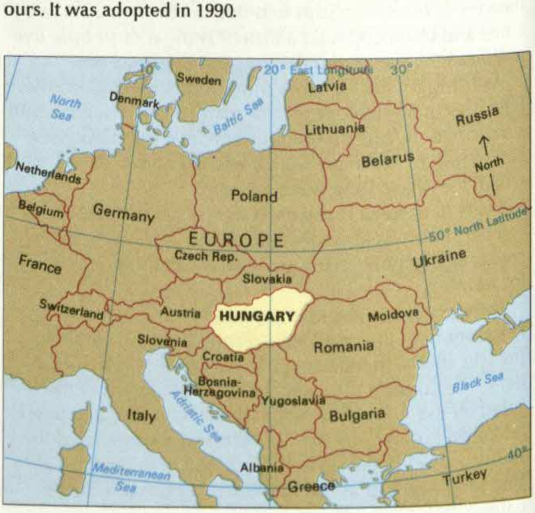
Armed forces. About 80,000 people serve in Hungary's army and air force. A large number also serve in the country's internal security force. Men may be conscripted for any of these services at age 18. Conscripts serve in the armed forces for 18 months.



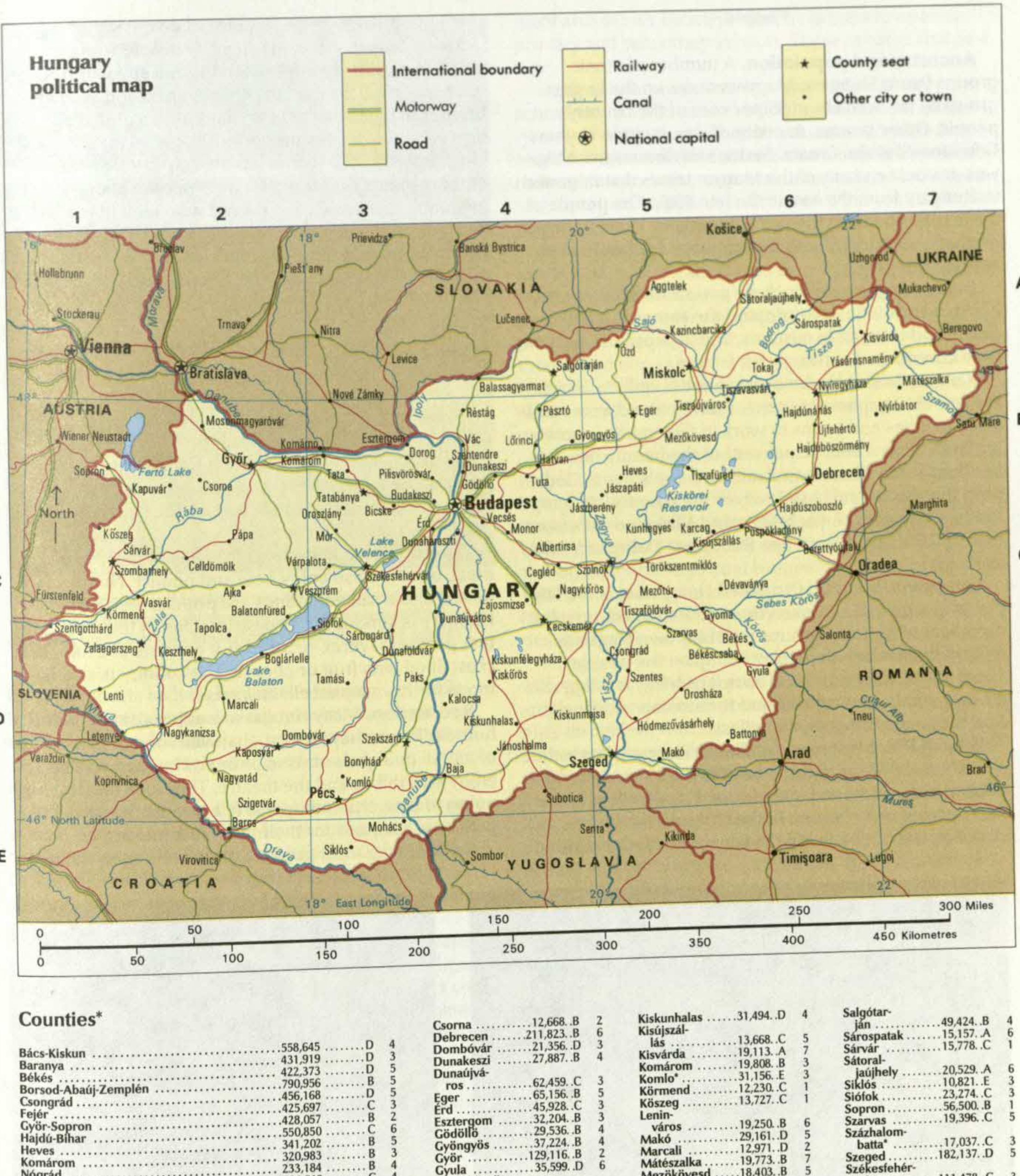
The Hungarian House of Parliament overlooks the Danube River in Budapest. The impressive building is the meeting place of the National Assembly, Hungary's parliament. It also houses a public library and various art treasures.



Symbols of Hungary. Hungary's flag has horizontal stripes of red, white, and green, the traditional national colours. It was adopted in 1957. The coat of arms also includes the national colours. It was adopted in 1990.



Hungary is a landlocked country in central Europe. It is surrounded by seven other countries.



Counties*

Bács-Kiskun	558,645	D	4
Baranya	431,919	D	3
Békés	422,373	D	5
Borsod-Abaúj-Zemplén	790,956	B	5
Csongrád	456,168	D	5
Fejér	425,697	C	3
Győr-Sopron	428,057	B	2
Hajdú-Bihar	550,850	C	6
Heves	341,202	B	5
Komárom	320,983	B	3
Nógrád	233,184	B	4
Pest	984,646	C	4
Somogy	353,441	D	2
Szabolcs-Szatmár	583,789	B	6
Szolnok	435,761	C	5
Tolna	265,938	D	3
Vas	279,520	B	1
Veszprém	387,856	C	2
Zala	313,031	C	1

Cities and towns

Ajka	34,068	C	2
Baja	40,375	D	4
Balassagyarmat	19,582	B	4
Balatonfüred	14,832	C	2
Barcs*	12,155	E	2
Békés*	22,202	D	6
Békéscsaba	70,441	D	6
Berettyóújfalu	17,613	C	6
Bonyhád	15,449	D	3
Budapest	2,075,990	C	4
Cegléd	40,114	C	4
Celldömölk	12,321	C	2
Csongrád	21,195	D	5
Csorna	12,668	B	2
Debrecen	211,823	B	6
Dombóvár	21,356	D	3
Dunakeszi	27,887	B	4
Dunaújváros	62,459	C	3
Eger	65,156	B	5
Érd	45,928	C	3
Esztergom	32,204	B	3
Gödöllő	29,536	B	4
Gyöngyös	37,224	B	4
Győr	129,116	B	2
Gyula	35,599	D	6
Hajdúböszörmény	31,232	B	6
Hajdúnánás	18,448	B	6
Hajdúszoboszló	24,208	C	6
Hatvan	24,949	B	4
Hódmezővásárhely	54,510	D	5
Jászberény	30,768	C	4
Kalocsa	20,023	D	4
Kaposvár	73,990	D	2
Kapuvár	11,322	B	2
Karcag	24,821	C	5
Kazincbarcika	39,136	A	5
Kecskemét	102,889	C	4
Keszthely	22,732	D	2
Kiskőrös	15,342	D	4
Kiskunfélegyháza	35,650	D	4
Kiskunhalas	31,494	D	4
Kisújszállás	13,668	C	5
Kisvárda	19,113	A	7
Komárom	19,808	B	3
Komlo*	31,156	E	3
Körmend	12,230	C	1
Kőszeg	13,727	C	1
Leninváros	19,250	B	6
Makó	29,161	D	5
Marcali	12,971	D	2
Mátészalka	19,773	B	7
Mezőkövesd	18,403	B	5
Mezőtúr	21,084	C	5
Miskolc	211,660	B	5
Mohács	21,491	E	3
Mosonmagyaróvár	29,833	B	2
Nagyatád	14,779	D	2
Nagykanizsa	55,336	D	2
Nagykőrös	26,794	C	4
Nyírbátor	14,179	B	7
Nyíregyháza	116,782	B	6
Orosháza	36,758	D	5
Oroszlány*	21,374	C	3
Ózd	47,167	A	5
Paks	25,056	D	3
Pápa	34,601	C	2
Pécs	177,104	E	3
Salgótarján	49,424	B	4
Sárospatak	15,157	A	6
Sárvár	15,778	C	1
Sátoraljaújhely	20,529	A	6
Siklós	10,821	E	3
Siófok	23,274	C	3
Sopron	56,500	B	1
Szarvas	19,396	C	5
Százhalombatta*	17,037	C	3
Szeged	182,137	D	5
Székesfehérvár	111,478	C	3
Szekszárd	38,364	D	3
Szentendre*	19,012	B	4
Szentes	35,664	D	5
Szigetvár	12,764	E	2
Szolnok	80,461	C	5
Szombathely	86,013	C	1
Tapolca	17,483	C	2
Tata	25,631	B	3
Tatabánya	76,465	B	3
Törökszentmiklós	24,483	C	5
Túrkeve*	11,209	C	5
Vác	35,874	B	4
Várpalota	28,665	C	3
Veszprém	64,071	C	2
Zalaegerszeg	61,456	C	1

*County names and names of cities marked with an asterisk do not appear on map; key shows general location.

Source: 1986 official estimates.

People

Ancestry and population. A number of ethnic groups live in Hungary. Magyars make up the largest group by far, with about 95 per cent of the country's people. Other groups, in order of size, include Gypsies, Germans, Slovaks, Croats, Serbs, and Romanians. Magyars are descendants of the Magyar tribes that migrated to Hungary from the east in the late 800's. The people of these tribes became the first Hungarians. Their language gradually developed into the language spoken in present-day Hungary.

Today, Magyars also include people of other ethnic backgrounds who have adopted the Hungarian language and Hungarian customs. These people, in turn, have contributed to Hungarian culture.

Hungary has a population of about 11 million. Since the late 1940's, many Hungarians have moved from rural areas to cities and towns to work in the country's growing industries. About 60 per cent of the people now live in urban areas. More than 2 million people live in Budapest, the capital and largest city in the country. Hungary has two other cities—Debrecen and Miskolc—with more than 200,000 inhabitants. See **Budapest; Debrecen; Miskolc**.

Language. Magyar (also called Hungarian) is the official language and is spoken throughout the country. But members of minority groups use their own language among themselves. In parts of Hungary, the people speak various *dialects* (local forms) of Magyar. Magyar is a *Uralic-Altaic* language related to Estonian and Finnish. See **Language** (Language families).

Way of life. Most rural families in Hungary live in small houses. Many of these houses have *stucco* (rough plaster) outer walls and a tiled roof. City dwellers live in flats or one-family homes. In the cities, housing construction has not been able to keep up with the rapid shift in population from rural to urban areas.

Most Hungarians, especially city dwellers, dress much as people do in Western Europe and North America. Many rural Hungarians once wore colourfully embroidered costumes as everyday clothing. But today, they wear these costumes only on special occasions. The Hungarian way of life has also changed in many other respects. For example, rural people once made beautiful objects, such as carved wooden utensils and embroidered linens, for everyday use. Although Hungarian craftworkers still produce such items, rural Hungarians now use manufactured household items that are like those used by people in other industrialized countries.

Hungarians love good food in large quantities, especially on holidays and other festive occasions. They enjoy soup with special as well as everyday meals. The most famous Hungarian soup is a thick soup, or stew, called *goulash*. It consists of cubes of beef or other meat, gravy, onions, and potatoes. Other ingredients may also be added to the goulash, which is highly flavoured with a seasoning called *paprika*. Hungarians use paprika in many of their dishes.

Hungarians eat more pork than any other kind of meat, but they also enjoy beef and poultry. Noodles, potatoes, and small dumplings are popular side dishes. Hungary is famous for its pastries. One of the most popular pastries is *rétes,* or *strudel*. It consists of a thin, flaky crust filled with fruit or cheese. The country is also famous for its many excellent wines.

Recreation. Many Hungarians enjoy visiting coffee houses. There, they read or chat with friends over a cup of coffee or a glass of wine or beer. Hungarians also enjoy art exhibits and the theatre. They love music, and going to concerts and operas is a popular pastime. Hungarians are famous for their lively folk music.

Soccer is the most popular sport in Hungary. Other

Budapest ranks as Hungary's largest city. It has nearly a fifth of the country's total population. In this scene, cars and pedestrians jam a busy street in one of the city's main shopping districts.

Colourful embroidery adds a traditional Hungarian touch to clothing and other items. Most such handcrafted items are used on special occasions or are exported.

Hungary's medicinal baths attract Hungarians and foreigners who believe the warm, mineral-filled waters have healthful qualities. This picture shows the famous Gellert Baths in Budapest.

favourite sports include basketball, fencing, and volleyball. Many Hungarians also enjoy swimming, boating, and fishing. In addition, the country has many health resorts called *spas,* which offer medicinal bathing in mineral waters.

Religion. About two-thirds of Hungary's people are Roman Catholics. Nearly one-fourth of the population are Protestants. The Reformed (Calvinist) Church and the Lutheran Church are the largest Protestant groups. Other religious groups include Catholics of the Byzantine Rite, Jews, and Unitarians.

After the Communists gained control of the government in the late 1940's, they tried to discourage religious worship. They placed religious groups under strict control and imprisoned some religious leaders. But many Hungarians strongly opposed these practices. In the 1960's, the government began to relax its policies against religion to gain the people's support. In 1989, changes in Hungary's Constitution granted the people complete religious freedom.

Education. Almost all adult Hungarians can read and write. Hungarian law requires children from 6 to 15 years of age to attend school. Hungary has eight years of primary school. Primary school graduates may then go on to a two-year *continuation* school or a four-year secondary school. Hungary has two main kinds of secondary schools—gymnasiums and vocational secondary schools. Gymnasiums, a traditional type of European secondary school, provide a general education. Vocational secondary schools offer training in agricultural, commercial, or industrial skills in addition to providing a general education.

The Hungarian government controls all educational institutions. All primary school and most secondary school students attend free state schools. The government also allows various religious groups to operate primary and secondary schools. These schools charge a fee.

Students who complete four years of secondary school may enter a school of higher education. Hungary's many institutions of higher education include five *academic* (general education) universities, five medical universities, and nine technical universities. The largest and most important universities are in the capital, Budapest.

Arts. Hungary's most outstanding contribution to the arts has been in music. The country has produced a number of world-famous composers. Franz Liszt was a prominent composer and pianist of the 1800's. The expressive and highly original works of Béla Bartók have established him as one of the greatest composers of the 1900's. His compositions and those of his friend Zoltán Kodály were strongly influenced by Hungarian folk music.

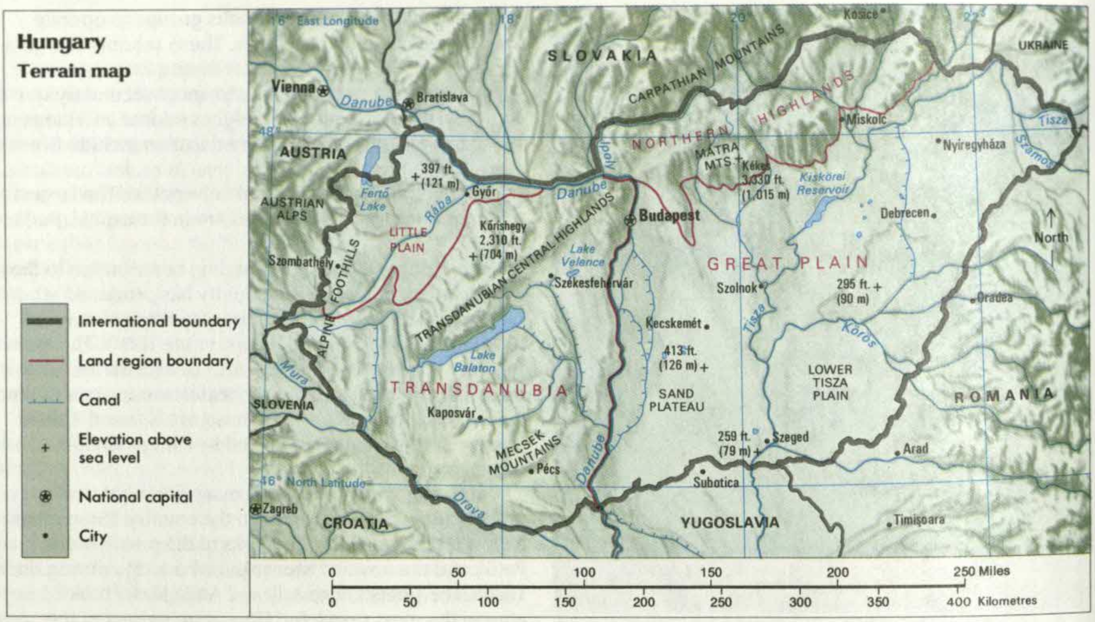
Hungary has also produced many fine writers. But few of them are known outside the country. Hungarians have a high regard for the works of the poet Sándor Petőfi and the novelist Mor Jókai, who wrote during the 1800's. The poets Endre Ady and Attila József rank among the most respected Hungarian writers of the 1900's. The most famous Hungarian author is Ferenc Molnár, who wrote many plays, novels, and short stories during the early 1900's.

Hungarian writers have traditionally been concerned with political and social problems. In the 1950's, for example, some writers expressed in their works the people's discontent with the Communist government. These authors thus spoke for the Hungarian people, whose desire for a better life led them to rebel in 1956. After the unsuccessful revolution, the writers who had criticized the government had to flee the country or were imprisoned. The government also clamped tight controls on literary and other artistic activities. In the 1960's, the government began to relax its controls on cultural life to make its rule more acceptable to the people. In 1989, constitutional changes gave the people complete artistic freedom.

Land and climate

Most of Hungary's land is low. About two-thirds of the country lies less than 198 metres above sea level. All of eastern Hungary is nearly flat, except for low mountains in the north. Mount Kékes, Hungary's highest point, rises 1,015 metres above sea level in these mountains. Western Hungary consists mainly of rolling hills and low mountains.

The country's longest river is the Tisza, which flows 579 kilometres from north to south through eastern Hungary. The Tisza is a branch of Hungary's most important river, the Danube. The Danube flows through seven European countries, including Hungary. It forms part of Hungary's northern border, then flows from north to south through the central part of the country. The Danube serves as the chief shipping route for trade between Hungary and its neighbours as well as for trade within the country. Lake Balaton in western Hungary is the largest lake in central Europe. It covers about 596 square kilometres and is a popular recreation and vacation spot.



Land regions. Hungary has four main land regions: (1) the Great Plain; (2) Transdanubia; (3) the Little Plain; and (4) the Northern Highlands.

The Great Plain covers all of Hungary east of the Danube River, except for the mountains in the north. The region occupies about half the country's area. Its nearly flat surface is broken only by river valleys, sand dunes, and small hills. The Great Plain is mostly agricultural. The southeastern section has Hungary's richest soil.

Transdanubia covers all of Hungary west of the Danube, except for the northwest corner of the country. Transdanubia consists mostly of hills and mountains. A chain of low, rounded mountains called the Transdanubian Central Highlands stretches along the entire northern side of Lake Balaton. The chain extends to the bend of the Danube north of Budapest. Gently rolling hills lie south of Lake Balaton, and more low mountains lie still farther south. The foothills of the Austrian Alps rise in the west. The southeastern part of Transdanubia is a major farm region.

The Little Plain occupies the northwest corner of Hungary and is the smallest land region. It is flat except for the foothills of the Austrian Alps along the western boundary. Most of the area is good for farming.

The Northern Highlands rise northeast of the Danube River and north of the Great Plain. This mountainous region forms part of the great Carpathian mountain system of central Europe. Many of the mountain slopes are steep. Thick forests, small streams, and spectacular rock formations help make the Northern Highlands a region of scenic beauty. It is also an important manufacturing and mining area.

Climate. The climate varies little throughout Hungary because the country is small and has no great variety of natural features. In general, Hungary has cold winters and hot summers. January temperatures average about −2° C, and July temperatures average about 21° C. Hungary receives an average of about 60 centimetres of *precipitation* (rain, snow, and other forms of moisture) yearly. May, June, and July are the wettest months.

Economy

Before World War II (1939-1945), Hungary was chiefly an agricultural country. After the Communists gained control of the government in the late 1940's, they began to manage the nation's economy. To carry out their programme, they started a series of highly detailed plans that stressed industrial development. As a result, Hungary became increasingly industrialized.

The government's economic plans required frequent readjustment, however. By the early 1950's, for example, the country's industries could not meet the government's extremely high production goals. Farm production lagged because the government did little to promote agriculture. Hungarians reacted strongly against these policies, and the government was forced to set more realistic industrial goals and place more emphasis on agriculture.

After the revolution of 1956, the Communist government began to ease its control of Hungary's economy. In 1968, it introduced some features of a free market system into the economy through a programme called the New Economic Mechanism (NEM). Under the NEM, the government still developed economic plans, but there were fewer guidelines than in earlier plans.

At first, the NEM resulted in higher economic growth and an improved standard of living. But opposition to the NEM within the Soviet and Hungarian Communist parties prevented the full development of the programme. Also, an increase in the price of petroleum and other raw materials in the 1970's resulted in inflation, slower economic growth, and a serious trade deficit. As a result, the NEM ended by the early 1980's.

In an attempt to reduce the trade deficit and restore economic growth, the government instituted sweeping changes in the economy during the 1980's. Company

Hungary's Lake Balaton ranks as the largest lake in central Europe. It lies among the gently rolling hills and low mountains of Transdanubia, a land region in western Hungary. The lake and its scenic surroundings make the area one of the country's most popular recreation spots.

managers were allowed more power in decision making. The government stopped funding some companies that lost money, and allowed successful companies to pay workers higher wages. It encouraged the formation of private businesses and businesses that formed partnerships with foreign companies. Despite these government attempts to make Hungary's economy more open, the trade deficit continued to grow.

In 1990, Hungary's newly elected non-Communist government began to introduce further reforms to limit government control over businesses. These reforms included the sale of state-owned business and were designed to increase competition and productivity in Hungary's economy. The Socialist government elected in 1994 continued these reforms.

Natural resources. Hungary's chief resources include its fertile soil and its climate, which is generally favourable for agriculture. Farms cover about three-quarters of the land and produce most of the food the people need. About 15 per cent of Hungary's land is forested. These forests cannot supply all the timber the country needs. Thus, large amounts of timber are imported.

Hungary's most important mineral deposits are of bauxite, the ore from which aluminium is made. The country also has coal, iron ore, manganese, natural gas, and oil. But the deposits of these minerals are small or of low quality. Hungary thus imports additional supplies. Uranium, the main source of nuclear energy, was discovered in the Mecsek Mountains near Pécs in the 1950's. Uranium mines were developed with the help of the Soviet Union.

Hungary's electric power production does not meet its needs, and so extra power is imported. In the 1980's, Hungary began constructing nuclear reactors. Energy from the reactors and conservation help reduce Hungary's dependence on imported oil and coal.

Service industries employ about 45 per cent of Hungary's workers. These industries include such economic activities as education, engineering, finance, health care, and trade. Hungary has several commercial banks and a national securities exchange in Budapest.

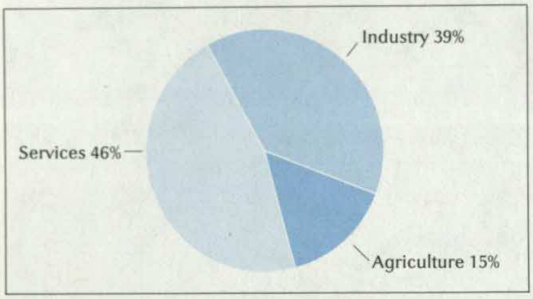
Engineering and trade are major employers in Hungarian service industries. Engineers help modernize Hungary's factories and manufactured products. Retail trade employs many people in the major cities. Important wholesale trade activities include exporting farm products and importing mineral products.

Manufacturing. The state owns about half of Hungary's factories. Since the early 1980's, private ownership has increased. Hungary's chief manufactured products include iron and steel, buses and railway equipment, electrical and electronic goods, food products, pharmaceuticals, medical and scientific equipment, and textiles. Hungarian plants also process much of the country's bauxite into alumina, which is the first step in producing aluminium. However, the second step—processing alumina into aluminium—is mostly done in other countries. Hungary lacks the large amounts of cheap electricity needed to process alumina into aluminium economically. The heaviest concentration of Hungary's factories is in the Budapest area.

Agriculture. Crops account for about 60 per cent of the value of Hungary's farm output, and livestock accounts for about 40 per cent. The chief crops include maize, potatoes, grapes, sugar beet, wheat, and wine grapes. Farmers raise more chickens and pigs than any other kind of livestock. Other livestock include beef and dairy cattle, horses, and sheep.

Until the end of Communist control of Hungary in

Hungary's gross domestic product



Hungary's gross domestic product (GDP) was 27,959,000,000 U.S. dollars in 1988. The GDP is the total value of goods and services produced within a country in a year. *Services* include financial, government, community, and personal services; trade; and transportation and communication. *Industry* includes construction and manufacturing, mining, and utilities. *Agriculture* includes agriculture, forestry, and fishing.

1992, only about 15 per cent of the country's farmland was privately owned. The rest was organized into large state farms and collective farms.

State farms covered about 15 per cent of the farmland. The government owned the land and appointed a director to manage each farm. Workers received a salary. Collective farms covered about 70 per cent of the farmland. On these farms, many families worked together. The workers owned the equipment and some of the farm's land as a group. Each member received a wage and a share of the farm's earnings.

Production and workers by economic activities

Economic activities	Per cent of GDP produced	Employed workers	
		Number of people	Per cent of total
Manufacturing, mining, & utilities	32	1,481,400	31
Financial, government, community, & personal services	31	1,111,800	23
Agriculture, forestry, & fishing	15	978,600	20
Trade	8	519,500	11
Construction	7	342,400	7
Transportation & communication	7	400,000	8
Total	100	4,833,800	100

Figures are for 1988. Sources: International Labour Organization; United Nations.

Beginning in 1992, the government began to break up the state farms and collective farms. Individual farmers were able to purchase their own land, and the Ministry of Agriculture was to retain a majority ownership of one-fifth of the state farms.

Foreign trade. Hungary's economy depends heavily on foreign trade. The leading imports into Hungary include products such as advanced machinery, cars, coal, cotton, electric power, fertilizers, iron ore, livestock feed, and oil. The country's chief exports include alumina, livestock, machinery, medicines, processed foods and beverages, steel, and transportation equipment, especially buses.

Hungary's main trading partners include Austria, the Czech Republic, Germany, Poland, and Slovakia. Russia is an important supplier of natural gas and petroleum.

Fertile farmland covers about three-quarters of Hungary and is one of the country's most important natural resources. Farmers in Hungary grow a wide variety of crops and raise livestock. Nagyvázsony, *above,* is a farm village in western Hungary.

In 1973, Hungary joined the General Agreement on Tariffs and Trade (GATT). About 100 countries belong to the GATT. All members have agreed to reduce trade barriers among themselves. In 1982, Hungary was admitted to the International Monetary Fund (IMF), which provides economic assistance to its members. See **General Agreement on Tariffs and Trade; International Monetary Fund.**

Transportation. The state owns and operates Hungary's railway system, which is about 7,800 kilometres long. Hungary has about 30,000 kilometres of roads, most of which are surfaced. Hungary has about one car for every eight people. Hungary's rivers and canals form a network of navigable waterways about 1,700 kilometres long.

The country has one shipping line and one airline. Both services are owned and operated by the state. The airline operates only international flights. Many foreign airlines also serve Budapest, which has the country's only civilian airport.

Communication. Hungary has more than 30 daily newspapers, which have a total circulation of about $2\frac{1}{2}$ million copies. Most families own a radio, and many own a television set.

History

Early years. People have lived in what is now Hungary for thousands of years. But the history of the Hungarian state began in the late 800's. At that time, tribes of Magyars swept from the east into the middle Danube Basin—the great lowland region bordering the Danube River that comprises most of present-day Hungary. The tribes were led by a chief named Árpád. As the Magyars advanced into the area, they began to set up settlements.

During the early 900's, Magyar armies raided towns throughout much of Europe. But in 955, the German king Otto I defeated the invading Magyars. The Magyars then ended their raids into western Europe and concentrated on the settlement of Hungary.

The Kingdom of Hungary. About 970, Árpád's great-grandson Géza became leader of the Magyars. Géza began to organize the various Magyar tribes into a united nation. After Géza died, his son, Stephen, carried on the work. Stephen, who was a Roman Catholic, asked Pope Sylvester II to give him the title king of Hungary. The pope agreed, and Stephen I, Hungary's first king, was crowned in 1000. As king, Stephen made Roman Catholicism the country's official religion. For this work, the Catholic Church declared him a saint in 1083, 45 years after his death. As a result of Stephen's reign, Hungary became closely identified with the culture and politics of western Europe.

Árpád's descendants ruled Hungary until 1301, when the last Árpád king died without an heir. During the 300 years of the Árpáds' reign, Hungary became firmly established as a Christian state. The country also faced its first great challenge from the east during this period. In 1241, armies of the Mongol Empire invaded Hungary. The Mongols were a warlike people of central Asia from the area of Mongolia, Manchuria, and Siberia. They had gradually extended their rule westward into eastern Europe. Within a few months, the Mongol armies had overrun much of Hungary. The death of the Mongols' ruler forced the invaders to withdraw from Hungary in 1242. But they left much of the country in ruins. Under the leadership of the Árpád kings, Hungary gradually recovered from the disaster.

After the death of the last Árpád king in 1301, Hungary remained an independent kingdom for 225 more years. One of the greatest kings during this period was Charles Robert, a member of the Italian branch of the Anjou dynasty. He ruled Hungary from 1308 to 1342. Charles Robert restored order in the country, which had been troubled by civil conflict since the end of the Árpád rule. He also weakened the power of the nobles and strengthened the monarchy. Hungary gained much land through the conquests of Charles Robert's son, Louis I, called "the Great." But the land Louis gained was lost during his lifetime and shortly after his death in 1382.

John Hunyadi, a Hungarian nobleman of Romanian descent, led the Hungarians in defeating the Ottoman Turks in 1456. The Turks had been advancing into Europe since the mid-1300's. Hunyadi's son Matthias Corvinus became king of Hungary in 1458. Like Charles Robert, Matthias worked to strengthen royal power. Hungary prospered during his reign. It also became a centre of the Italian Renaissance, the great artistic and cultural movement that spread across Europe during the 1400's and 1500's.

A period of conflict and disorder followed Matthias's death in 1490. The Hungarian *Diet,* which was an assembly of noblemen similar to a parliament, gained much political power during this period, and the monarchy grew weak. At that time, most of Hungary's people were peasants who worked under wretched conditions for the nobles. As the nobles increased their power, they began to make the peasants' lives even more miserable. The peasants revolted in 1514. However, the nobles soon put down the uprising. After the revolt, the peasants were condemned to *serfdom* (a condition similar to slavery).

Ottoman and Habsburg rule. Hungary, weakened by internal problems, was defeated by the Ottoman Empire in the Battle of Mohács in 1526. The defeat paved the way for the country's occupation by foreign troops. The Ottomans seized central Hungary soon after 1526. They made the eastern third of the country, a region called Transylvania, a *principality* (small state ruled by a prince) dependent on them. The Austrian Habsburgs, who had long wanted to make Hungary part of their empire, took the country's western and northern sections. In the late 1600's, Habsburg forces drove the Ottomans out of most of Hungary. The Habsburgs gained complete control of the country in the early 1700's.

The Habsburgs governed Hungary, especially the Protestant sections, harshly. The Protestant Reformation had begun in Germany in the 1500's and gained many followers in Hungary. Transylvania, in particular, had developed a tradition of religious freedom, which allowed Protestants and Unitarians as well as Catholics to establish churches. The harsh rule of the Habsburgs led to a nationwide uprising in 1703. It was headed by Francis Rákóczi II, a Catholic and the son of a prominent family that included princes of Transylvania. The Habsburgs finally put down the revolt in 1711. But it had persuaded them to relax their rule and improve economic and political conditions in Hungary. During the rest of the 1700's, most Hungarians accepted and benefited from this change of policy.

In the early 1800's, Count Stephen Széchenyi led a movement to revive Hungarian culture and national pride. He also promoted economic and social reforms. In the 1840's, Louis Kossuth became the most important leader of the reform movement and eventually turned it into a drive for Hungarian independence.

During the 1840's, democratic and liberal nationalist movements were sweeping over Europe. Revolution broke out in France in 1848 and heightened the unrest in other European countries (see **Revolution of 1848**). In Hungary, a government responsible to parliament was formed with Austrian consent in 1848. Other changes were also made, including the freeing of the serfs. But Hungary had not cut all ties with Austria, and disagreements between the two countries finally led Hungary to fight for its independence. Kossuth became head of a revolutionary Hungarian government, which declared the country's complete independence from Austria in April 1849. But the Austrians, aided by the Russians, defeated the Hungarian army in August of that year, and Hungary again came under Habsburg rule.

Austria-Hungary. Austria's power was soon shaken by two defeats. It lost a war with France and Italy in 1859 and with Prussia and Italy in 1866. In 1867, the Hungarians, led by Francis Deák, were thus able to force the emperor of Austria, Francis Joseph, to give Hungary equal status with Austria. Under this arrangement, called the *Dual Monarchy,* both countries had the same monarch and conducted foreign, military, and certain financial affairs jointly. But each country had its own constitutional government to handle all other matters. The creation of Austria-Hungary was followed by a period of prosperity in the two countries. During the next 50 years, Hungary's economy, educational system, and cultural life developed rapidly.

Austria-Hungary included many Slavs, Romanians, and other national groups. These groups made up nearly half of Hungary's population. In the late 1800's and early 1900's, many of the national groups in Hungary began to demand the right of self-government. But most of the Hungarian politicians failed to heed these demands.

In 1914, a Bosnian student killed the heir to the Austro-Hungarian throne. Austria-Hungary suspected that its southern neighbour Serbia was responsible for the killing. As a result, Austria-Hungary declared war on Serbia, marking the start of World War I (1914-1918). In the war, Germany, Bulgaria, and the Ottoman Empire supported Austria-Hungary, forming the Central Powers. The Central Powers fought against Serbia, France, Russia, the United Kingdom, and other countries that made up the Allies. The United States entered the war on the Allied side in April 1917. See **World War I**.

Between world wars. A defeated Austria-Hungary signed an armistice on Nov. 3, 1918. On November 16, the Hungarian people revolted and declared Hungary a republic. Count Michael Károlyi became president. But Hungarian Communists and Socialists joined together to form a *coalition* government in March 1919. Károlyi resigned, and Béla Kun, leader of the Communists, took control of the new government as a dictator.

Kun's rule lasted only a few months. It collapsed largely because Kun could not defend Hungary against armed attacks by Romania, which sought Hungarian territory. Romanian troops occupied much of Hungary, including Budapest. In addition, most Hungarians did not support Kun's policies, which included taking over the country's factories and farms. Late in 1919, Admiral Nicholas Horthy came to power. His conservative government lasted 25 years. Under Horthy, Hungary again became a monarchy, though it had no king. Instead, Horthy ruled as *regent* (in the place of a monarch).

Hungary and the Allies signed the Treaty of Trianon in 1920. The treaty was part of the World War I peace settlements. It stripped Hungary of more than two-thirds of its territory. Parts of Hungary went to Czechoslovakia, Romania, Austria, and Yugoslavia. Hungary's present boundaries are about the same as those set by the treaty. See **Trianon, Treaty of**.

World War II. The rise of Nazi Germany in the 1930's had far-reaching effects on Hungary. Adolf Hitler, the German dictator, promised the return of some territory

Important dates in Hungary

Late 800's The Magyars conquered Hungary.

1000 Stephen I became Hungary's first king and converted the country to Roman Catholic Christianity.

1241 The Mongols invaded Hungary.

1458-1490 Matthias Hunyadi ruled Hungary and helped make it a centre of Italian Renaissance culture.

1526 The Ottoman Empire defeated Hungary in the Battle of Mohács. Soon afterward, the Ottomans occupied central and eastern Hungary.

1600's Austrian Habsburg forces drove the Ottomans out of Hungary and took control of the country.

1703-1711 Francis Rákóczi II led an unsuccessful uprising to gain Hungarian independence.

1848 Louis Kossuth led an anti-Habsburg revolution, which was defeated the following year.

1867 The Dual Monarchy of Austria-Hungary was established.

1914-1918 Austria-Hungary was defeated in World War I.

1918 Hungary became a republic.

1919 Béla Kun established the first Hungarian Communist government. It lasted only a few months.

1919-1944 Admiral Nicholas Horthy, a conservative, ruled Hungary as a *regent* (in the place of a king).

1941 Hungary entered World War II on Germany's side.

1944 Germany, which mistrusted Hungary as an ally, occupied the country.

1945 Hungary and the Allies signed an armistice.

1946 Hungary again became a republic. The new government started political, economic, and social reforms.

1946-1949 Hungarian Communists gradually gained control of the government.

1947 The Allies signed a peace treaty with Hungary that confirmed the terms of the 1945 armistice.

1955 Hungary became a member of the United Nations.

1956 Soviet forces crushed an anti-Communist revolution in Hungary.

1988 Hungary's Communist Party agreed to allow other political parties to operate in the country.

1990 Multiparty elections marked the end of the 40-year rule of the Hungarian Communist Party.

that Hungary had lost under the Treaty of Trianon. Beginning in 1938, Hitler allowed Hungary to take parts of Czechoslovakia, Romania, and Yugoslavia. In April 1941, Hungary aided Hitler in an attack on Yugoslavia and so entered World War II. It joined Germany, Italy, and other Axis countries in fighting the Allies, which included the United Kingdom, France, and, by the end of 1941, China, the Soviet Union, and the United States. Japan entered the war on the Axis side in December 1941.

By 1943, Hitler no longer considered Hungary a reliable ally. He seized the country in March 1944. More than 500,000 Hungarian Jews were shipped to German concentration camps, where most of them were put to death in gas chambers. The Germans jailed Horthy in October and set up a Hungarian Nazi government.

The Soviet Union invaded Hungary late in 1944, and Hungary and the Allies signed an armistice in January 1945. Hungary agreed to give up all the territory it had gained since 1938. Hungary and the Allies signed a peace treaty in 1947. See **World War II.**

Communist Hungary. Elections were held in November 1945. Early the next year, Hungary was declared a republic. After the November elections, a coalition government was formed. This government introduced many social and economic reforms, including land distribution among the peasants. The coalition consisted of the Smallholder, Social Democratic, Communist, and National Peasant parties. The Smallholders had won a clear majority of the votes in the elections. However, Communists gradually gained control of the government, largely because of the continued presence of Soviet troops in Hungary.

Elections were held again in 1947, and the Communists again failed to win a majority of the votes. But by then, they held enough key government posts to extend their control over the country. They eliminated all opposition parties and, in 1949, gave Hungary a constitution patterned on that of the Soviet Union.

Matthias Rákosi, head of the Communist Party and head of the Hungarian government, ruled as a dictator. By the early 1950's, his policies had nearly ruined the economy and produced widespread discontent among the people. In 1953, Imre Nagy replaced Rákosi as premier. But Rákosi remained head of the party. Nagy adopted policies that gave Hungarians more personal freedom and that aimed at improving their living conditions. But Rákosi and other party members opposed these reforms. As party leader, Rákosi forced Nagy out of the government and the party in 1955.

Rákosi's policies again caused unrest, especially among writers, young people, and others deeply concerned with human rights and freedom of expression. Rákosi was replaced as party leader in mid-1956, but his policies were continued. In October, discontent with these policies erupted into street fighting in Budapest. The revolution spread swiftly through Hungary. Many political prisoners were freed, including Joseph Cardinal Mindszenty, head of the Catholic Church in Hungary. The Communists had jailed him in 1949. Nagy again became premier and declared Hungary to be a neutral country. But the new government lasted only a few days. Soviet forces poured into the country and put down the uprising in November.

Many Hungarians were killed or imprisoned as a result of the 1956 revolution. About 200,000 fled the country. Nagy and his co-workers were charged with helping plot the revolution. They were convicted of treason, and were executed in 1958.

After the 1956 revolution, the Soviet Union kept Hungary under tight control. János Kádár, the new head of the Communist Party, served as premier from 1956 to 1958 and from 1961 to 1965. At first, he followed stern policies designed to prevent further revolutionary acts. But in the 1960's, Kádár's government tried to win increased support from the people by easing some of its restrictions on cultural, economic, and social life. In 1968, the government adopted a new economic programme that introduced features of a free market system into the socialized economy.

Recent developments. The standard of living improved in Hungary during the early years of the new economic programme. In the late 1970's, however, living standards began to decline as a result of a worsening economy. Kádár's opposition to further economic reforms led to his replacement as head of the Communist Party by Károly Grósz in 1988. Grósz had been appointed premier in 1987. Miklós Németh replaced Grósz as premier at the end of 1988. New political parties appeared, and parties destroyed by Communists in the late 1940's began to reorganize.

In 1989, the Communist Party declared that the trial of Imre Nagy and his co-workers and their executions in 1958 had been illegal. Hungary's Supreme Court invalidated the unlawful sentences. Nagy and his co-workers were ceremoniously reburied with honour in June 1989.

In late 1989, Hungary made sweeping revisions in its constitution. The revisions further increased the freedom of the people. The revisions also changed the structure of the government from a one-party Communist state to a multiparty democratic, parliamentary system. A new office of president was created. The president became the country's top government official. Matyas Szuros was chosen to serve as president until multiparty elections were held. Hungary's first multiparty elections since 1949 were held in March and April 1990. The Hungarian Democratic Forum—a non-Communist party—won a majority of the parliamentary seats. It formed a coalition government with two smaller non-Communist parties, the Independent Smallholders' Party and the Christian Democratic People's Party. The coalition selected Arpád Göncz as the new president. Joseph Antall was prime minister until his death in 1993, being replaced by Peter Boross. In elections in 1994, the Hungarian Socialist Party, the former Communists, won a majority. It formed a coalition with the Alliance of Free Democrats. Gyula Horn became prime minister.

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Outline

- **I. Government**
  - A. National government
  - B. Local government
  - C. Courts
  - D. Armed forces
- **II. People**
  - A. Ancestry and population
  - B. Language
  - C. Way of life
  - D. Recreation
  - E. Religion
  - F. Education
  - G. Arts
- **III. Land and climate**
  - A. Land regions
  - B. Climate
- **IV. Economy**
  - A. Natural resources
  - B. Service industries
  - C. Manufacturing
  - D. Agriculture
  - E. Foreign trade
  - F. Transportation
  - G. Communication
- **V. History**

Questions

Who were the first Hungarians?
How do the surface features of the Great Plain differ from those of Transdanubia?
What are some popular recreational activities in Hungary?
How do cooperative farms differ from state farms in Hungary?
What Hungarian lake is the largest lake in central Europe?
Why were the Communists able to gain control of Hungary's government after World War II?
What are some of Hungary's chief imports and exports?
What is *goulash*?
What political role did some Hungarian writers play in the period before the 1956 revolution?

Hunger is an unpleasant, often painful sensation caused by the body's need for food. The most familiar hunger pains are stomach cramps, which are produced by strong contractions of the stomach muscles. Many experts believe that hundreds of millions of children and adults throughout the world suffer from hunger. This article discusses both the physical and social aspects of hunger.

Certain chemicals produced in the brain and other parts of the nervous system play an important role in regulating the sensation of hunger in human beings. An imbalance of these chemicals may increase or decrease the sensation. The amount of *glucose* (sugar) in the blood also affects hunger. People may become hungry if their bodies have less than a normal amount of glucose.

People need many substances besides glucose to avoid being hungry. These substances include vitamins, minerals, and amino acids. *Internal chemoreceptors* are sensitive receivers in the brain, kidneys, digestive system, and elsewhere in the body that respond to the amount of available glucose and other needed substances (see **Senses**). Nerve impulses from these receptors reach a region of the brain stem called the *hypothalamus.* Here these impulses are translated into detection of a need for the substances that are lacking. This action may lead to eating the needed foods.

Social habits also affect hunger and eating in human beings. People eat at certain times, and they usually eat only certain foods. Sometimes signals from internal receptors that do not give information on hunger are interpreted as hunger. A person may then overeat and become overweight.

Hunger is one of the world's main social problems. One reason is that the world's growing population creates a greater demand for food every year. But droughts, floods, or other natural disasters destroy many food crops annually. In addition, most of the developing countries of Africa, Asia and Latin America lack the expertise and equipment needed to produce adequate food supplies for most of their people. Furthermore, in both developing and developed countries, millions of people suffer from hunger because they are too poor to buy enough food.

See also **Developing country; Food supply; Nutrition; Poverty; Weight control.**

Hunt, Lord (1910-), John Hunt, Baron Hunt of Llanvair Waterdine, led the expedition that conquered Mount Everest in 1953. The members of the expedition to reach the summit were Sir Edmund Hillary and Tensing Norgay. Hunt, a Briton, was knighted for his part in the expedition. His book *Ascent of Everest* (1953) describes the exploit. Hunt was born in Simla, India, and named Henry Cecil John Hunt. After attending Sandhurst, he was commissioned in 1930. He retired from the British Army in 1956 with the rank of brigadier. He was director of the Duke of Edinburgh's Award Scheme from 1956 to 1966, and received his peerage in 1966.

Hunt, Leigh (1784-1859), was an English journalist, essayist, and poet. He was a supporter of such English romantic poets as John Keats and Percy Bysshe Shelley when they were largely ignored or ridiculed. Hunt edited several periodicals, and much of his best work appeared as literary and informal essays in these publications. Only a few of Hunt's poems are still read, notably "The Story of Rimini" (1816) and "Abou Ben Adhem" (1834). He described his friendships with major romantic and early Victorian writers in his *Autobiography* (1850).

James Henry Leigh Hunt was born in Southgate, a London suburb. With his brother John, Hunt founded a liberal weekly newspaper called the *Examiner* in 1808. Hunt was imprisoned from 1813 to 1815 for his attacks on the future King George IV in the *Examiner.*

Hunt, Sam (1946-), a New Zealand poet, first became known in the 1960's for entertaining audiences in hotels, theatres, and town halls with his unique brand of poetry. Dressed characteristically in winklepicker boots and drainpipe trousers, Hunt drove throughout New Zealand in his old *Valiant* car with his dog Minstrel, who was the subject of many of his poems. In 1984, Prime Minister David Lange appointed Hunt as a cultural ambassador for New Zealand. Hunt was born in Auckland.

Hunt, William Holman (1827-1910), was one of the painters of the Pre-Raphaelite Brotherhood (see **Pre-Raphaelite Brotherhood.** He was born in London and entered the Royal Academy at the age of 18. At first, Hunt painted scenes from the novels of Dickens and

Scott. He later painted biblical subjects, the best known being *The Light of the World.*

Hunter is the family name of two brothers who were famous British physicians.

William Hunter (1718-1783) was a brilliant anatomist. He founded the Windmill Street school of anatomy. He introduced into Britain dissection methods used in Paris.

John Hunter (1728-1793) was a celebrated pathologist and surgeon who made important contributions to the understanding of diseases and surgical techniques. He investigated the structures of the placenta and of teeth, wrote an important paper on venereal diseases, and was the first person to recognize the cause of phlebitis. In 1785, he performed a revolutionary operation for aneurysm. John Hunter's extensive collection of anatomical specimens was bought for the nation.

Hunter, John (1737-1821), was the second governor of New South Wales, Australia. He held the position from 1795 to 1800. Arthur Phillip, the first governor, left the colony in 1792. Between 1792 and 1795, successive commanders of the New South Wales Corps acted as lieutenant governors. They allowed their officers to become large landowners, and to monopolize trading in the colony. The British government commissioned Hunter to restore discipline. He soon came into conflict with the officers of the corps. But despite his efforts, private landholding, the assigning of convicts as servants, and trading in rum continued.

John Hunter

Hunter was born in Leith, Scotland. He became a lieutenant in the British navy in 1780. In 1788, he was appointed captain of H.M.S. *Sirius.* He became a vice admiral in 1810.

Hunting is the sport of capturing or killing wild animals. At one time, people could get their food only if they hunted for it. Today, however, most people hunt because they enjoy it as a sport.

What makes hunting a sport. Many people do not like to hunt, because they dislike killing wild animals. But, for most hunters, the killing itself is not important. They receive most of their satisfaction from outwitting the animals they are hunting. True hunting is a contest between the hunter and the hunted. Weapons give the hunter an advantage. But animals also have advantages. They can run faster than the hunter, they know the land better, and they can smell and hear much better. Therefore, hunters must know the habits of the animal. Many hunters enjoy the sport because it takes them outdoors and gives them a chance to study the habits of wild creatures. Trained hounds can help the hunters chase and capture a variety of animals. These dogs are especially bred for hunting. Hound dogs follow the scent of animals. Pointing dogs such as setters, pointers, and spaniels discover game by scent and then show the hunter the game by *pointing* (standing in a rigid position).

Game laws are laws that regulate the kind and amount of animals that can be hunted. The laws also govern the methods and seasons used to take certain game. In many cases hunters must buy a hunting licence. Many local and national governments have established game reserves where there can be no hunting.

Kinds of hunting depend on the game being hunted, the traditions of the country, and the methods used to catch the animal. Duck hunters use shotguns and the cartridges are loaded with small shot. Larger shot is used to kill deer. Big game hunters use an exceptionally powerful rifle. In the United States some hunters use only a bow and arrow.

In the British Isles, hunting is mainly confined to the sport of chasing and killing foxes, *stags* (deer), or hares. The hunters use a pack of hounds, which discover and pursue the quarry by its scent. Hunting does not include shooting and trapping.

Fox-hunting is the pursuit of foxes. Foxes give off a strong scent from glands near their tails and from an oily substance on their feet. Foxhounds follow foxes by scent. Hunters follow on horses. After harvest time, young foxhounds are trained by *cub-hunting* (chasing fox cubs).

Stag-hunting resembles fox-hunting. Hunters on

Horses and hounds set off across the English countryside, *left.* The hounds follow the fox by scent.

horseback ride behind staghounds, which follow stags by their scent.

Hare-hunting may be done on horseback or on foot. Hares tend to run in wide circles when they are chased. Hare hunters on horseback are called *harriers.* Those on foot go *beagling* with a special breed of dogs called *beagles.* Many people oppose hunting because they think it is cruel. They say that more humane ways of controlling the numbers of foxes and deer should be found. Groups of such reformers, called *hunt saboteurs,* frequently attempt to disrupt a hunt by putting the hounds off the scent.

In Australia, deer are the most exciting quarry for hunters. Only six species live in Australia. Deer were originally introduced from other countries. Ducks are the quarry most frequently hunted. Most states have limited *open seasons* for duck shooting—that is, seasons in which duck shooting is permitted.

Related articles in *World Book* include:

Ammunition
Fox hunting
Indian, American (pictures)
Inuit (Hunting and fishing)
Prehistoric people (How prehistoric hunters lived)
Safari
Shotgun
Trapping
Wildlife conservation

Hunting dog. See **Dog** (Sporting dogs; pictures).

Hunting leopard. See **Cheetah.**

Huntingdonshire (pop. 140,700) is a local government district in western Cambridgeshire, England. The district covers a large agricultural area and has its administrative offices in the town of Huntingdon. The district also has a long-established industry making agricultural machinery and has developed a number of new industries in recent years. The River Great Ouse flows through the towns of St. Neots, Huntingdon, and St. Ives. The district for many years had the name *Huntingdon.* See also **Cambridgeshire.**

Huntington's disease is a severe hereditary disorder of the nervous system. It destroys brain cells and causes involuntary body movements, mental disturbances, and eventual death. The disorder was named after George Huntington, an American doctor, who first described it in 1872. The condition is also called *Huntington's chorea* (see **Chorea**).

The symptoms in most cases of the disease begin when the person is from 35 to 40 years old. But some cases start in childhood or old age. Patients live an average of 15 years after the first symptoms of the disease appear.

The first physical symptom of the disease may be slight clumsiness or restlessness. Later, muscles in the face and hands begin to move involuntarily. Involuntary facial movements include pouting of the lips, irregular raising of the eyelids, and puffing out of the cheeks. As the disease progresses, the involuntary movements become stronger and eventually involve the whole body. The head, shoulders, arms, and legs jerk uncontrollably. When the patient walks, voluntary and involuntary movements combine and produce lurching, dancelike steps. Early mental symptoms include dullness and irritability, and carelessness about personal grooming. The disease gradually destroys the patient's intellect and memory. Severe mental illness may develop.

The patient may finally lose all muscle control and mental ability. Death results from pneumonia, choking, or other complications of the disease. Some patients become depressed and commit suicide.

Huntington's disease is caused by an abnormal gene located on one of a pair of chromosomes designated as *chromosome 4.* Anyone who inherits this gene will eventually be stricken by the disorder. Each child of a patient with the disease has a 50 per cent chance of inheriting the gene.

Doctors are not certain how widespread Huntington's disease is, because some patients may be misdiagnosed as suffering from schizophrenia or some other mental illness. Experts estimate that of every 100,000 people, 2 to 9 have the gene for the disease. Researchers have developed a test to identify people who carry the gene but who have not yet developed the disease. The test requires tissues or fluids from family members of the test subject, including samples from a family member known to have the disease and from one who does not. As a result, the test is not useful to many people who carry the gene. Huntington's disease has no cure. However, many of the symptoms may be eased by drugs and other forms of treatment.

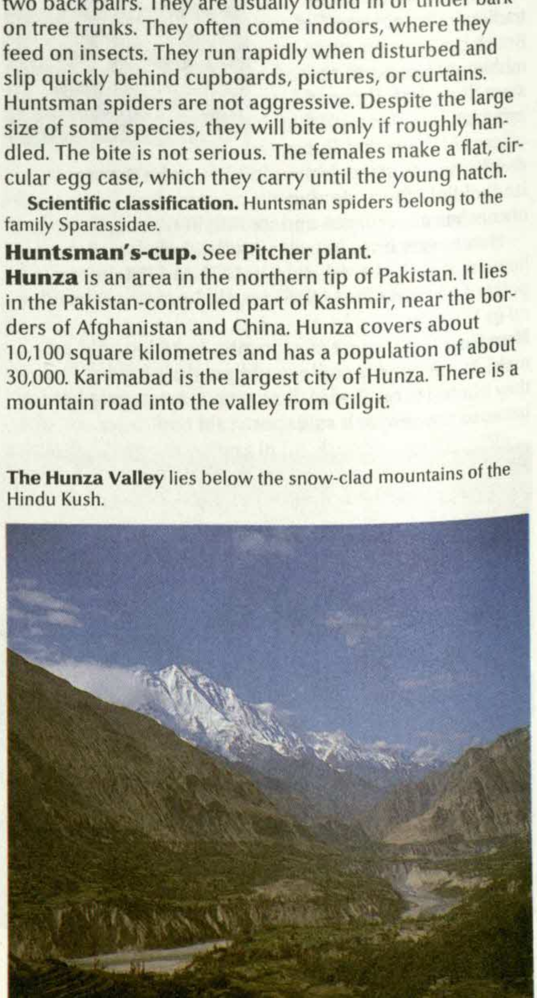
Huntsman spider is common in Australia, where there are about 100 species. The spiders have flat bodies. Their two front pairs of legs are longer than their two back pairs. They are usually found in or under bark on tree trunks. They often come indoors, where they feed on insects. They run rapidly when disturbed and slip quickly behind cupboards, pictures, or curtains. Huntsman spiders are not aggressive. Despite the large size of some species, they will bite only if roughly handled. The bite is not serious. The females make a flat, circular egg case, which they carry until the young hatch.

Scientific classification. Huntsman spiders belong to the family Sparassidae.

Huntsman's-cup. See **Pitcher plant.**

Hunza is an area in the northern tip of Pakistan. It lies in the Pakistan-controlled part of Kashmir, near the borders of Afghanistan and China. Hunza covers about 10,100 square kilometres and has a population of about 30,000. Karimabad is the largest city of Hunza. There is a mountain road into the valley from Gilgit.

The Hunza Valley lies below the snow-clad mountains of the Hindu Kush.



Hunza consists of a long, narrow valley in the Karakoram mountain range. Most Hunzukuts are farmers who grow such crops as barley, grapes, plums, and wheat. The chief industries are the production of woollen cloth and fine handicrafts.

Many of Hunza's people live more than 90 years. They believe that mineral-rich mountain water and a simple diet contribute to their long life. Their diet consists chiefly of fruit, such as apricots and peaches, and grains, nuts, and vegetables. The majority of the people speak a language called *Burushaski.* They have no written language. Most Hunzukuts are Muslims, and Islamic religious holidays are important to them.

No one knows who first lived in what is now Hunza. According to legend, three soldiers from the army of Alexander the Great settled there with their Persian wives during the 300's B.C. For hundreds of years, Hunza was an isolated state ruled by a *Mir* (prince). Pakistan gained control of Hunza in 1949, as a result of a United Nations truce that ended fighting between Pakistan and India in Kashmir (see **Kashmir**). The Mir was allowed to rule over local matters until 1974, when Pakistan took over complete control.

Huon pines grow naturally along or near rivers in the cool, temperate rainforest of western and southwestern Tasmania, Australia. The timber is the best of the Tasmanian softwoods. It is durable, soft, smooth, oily, and straight-grained. Once felled in large numbers for boatbuilding and joinery, Huon pines are now rare.

Scientific classification. Huon pines belong to the Podocarpaceae family. They are *Dacrydium franklinii.*

Hurd, Douglas (1930-), was the United Kingdom's foreign secretary from 1989 to 1995. He had previously been home secretary from 1985 to 1989, and secretary of state for Northern Ireland in 1984. He also served as minister of state in the Foreign Office from 1979 to 1983, and in the Home Office from 1983 to 1984. Douglas Hurd was educated at Eton and Cambridge. He worked in the British diplomatic service before starting a political career. He was elected to Parliament in 1974.

Hurdling is an athletics race in which runners jump over fencelike obstacles called *hurdles.* Most races have 10 hurdles that stand at equal intervals on the track.

High-hurdlers leap over the final hurdle in this exciting track event. Outstretched arms maintain balance and help the runners to "scissor" their legs over the 106.7-centimetre bars.

There are two types of hurdle races: intermediate and high. Intermediate-hurdle races are over 400 metres. The hurdles are 91.4 centimetres high for men and 76.2 centimetres high for women.

Most high-hurdle races for men are 55 metres indoors and 110 metres outdoors. Women run a 100-metre high-hurdle race. In men's competition, the hurdles are 106.7 centimetres high. High hurdles in women's races are 84 centimetres high.

In men's high-hurdle races, the first hurdle is 14 metres from the starting line in the 110-metre event. In the women's high hurdles, the first hurdle is 13 metres from the starting line. In all intermediate-hurdle races, the first hurdle is 45 metres from the starting line.

In a hurdle race, runners must adjust their stride so that they clear the hurdle without breaking stride. The race begins from a sprinting position. Runners jump over the hurdle straight on. The lead leg goes over the hurdle first, and the other leg is brought up behind so it also clears the hurdle. Runners keep their speed and gain momentum and balance by thrusting their arms toward the lead leg. Runners snap the lead leg down, then bring their trailing leg through so that they are in a running position.

Hurdlers must run in lanes. They are disqualified if they allow a foot or leg to trail along the side of a hurdle or if they clear a hurdle that is not in their lane. Runners are not penalized for knocking down hurdles in their own lane.

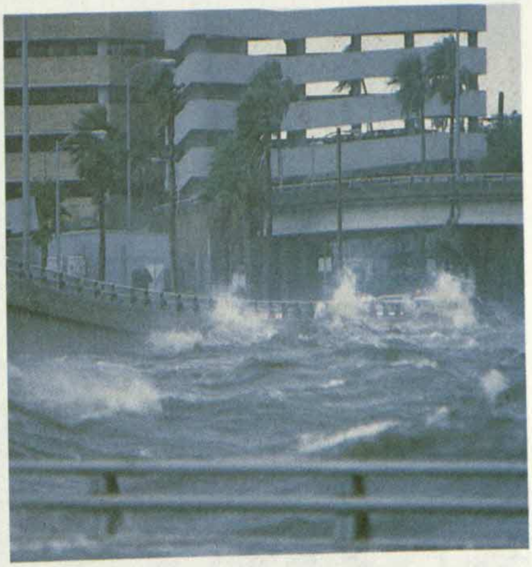
For hurdling championship figures, see the tables with **Athletics** and **Olympic Games.**

Hurdy-gurdy. See **Hand organ.**

Hurling. See **Gaelic games.**

Huron, Lake. See **Lake Huron.**

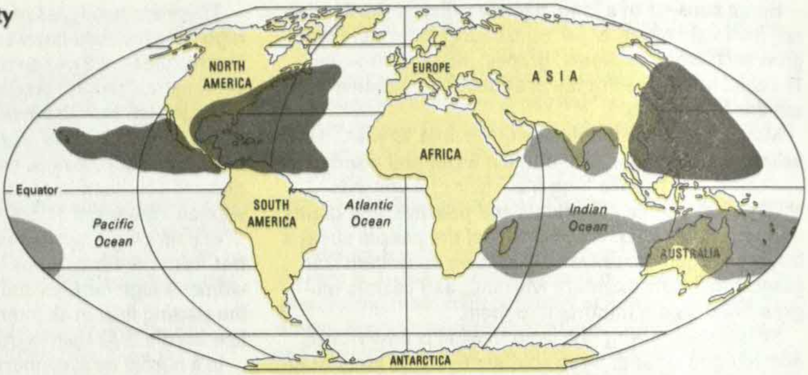
Hurricane is a powerful, whirling storm that measures 320 to 480 kilometres in diameter. The winds near the centre of a hurricane blow at speeds of 120 kilometres



Huge waves caused by a hurricane produce floods that can destroy life and property. About 90 per cent of the deaths that occur during hurricanes result from drowning in floods.

Regions of hurricane activity

Hurricanes develop over warm ocean water. They weaken after moving over land areas. This map shows the regions in which most hurricanes occur.



Average number of hurricanes per year

▩ More than 5

▨ Less than 5

per hour or more. Many hurricanes have caused widespread death and destruction.

Hurricanes develop from *easterly waves.* These long, narrow regions of low pressure occur in ocean winds called *trade winds.* Easterly waves may grow into a *tropical depression,* with winds of up to 50 kilometres per hour; then into a *tropical storm,* with winds of up to 120 kilometres per hour; and finally, into a hurricane.

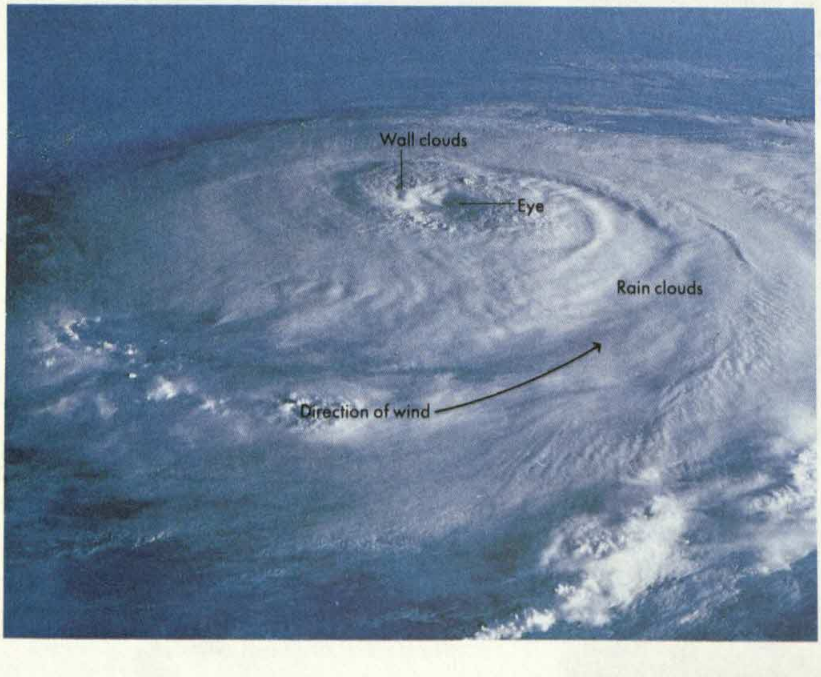
Hurricane winds swirl around the *eye,* a calm area in the centre of the storm. The eye of a hurricane measures about 32 kilometres in diameter and has few winds or clouds. Storm clouds called *wall clouds* surround the eye. The strongest winds and heaviest rain of a hurricane occur within its wall clouds.

A hurricane is an area of low air pressure that forms over oceans in tropical regions in either the North Atlantic Ocean or eastern North Pacific Ocean. Such a storm in the western Pacific Ocean is called a *typhoon,* and one in the Indian Ocean is called a *cyclone.*

Hurricanes occur in the North Atlantic and North Pacific oceans from June to November—most of them in September. On the average, about six to eight hurricanes form in the North Atlantic or North Pacific each year.

Movement. In the Northern Hemisphere, hurricane winds blow around the eye in an anticlockwise direction. They blow clockwise in the Southern Hemisphere. Hurricane eyes travel at speeds of 16 to 24 kilometres per hour. Most hurricanes move westward at first and become larger and stronger as they travel. Then they turn from the equator and pick up speed. Most hurricanes turn east after they reach temperate latitudes, where they are called *extra-tropical storms.* Many end as weak storm centres over cool oceans.

Destructive power. In many hurricanes, winds in the wall cloud area blow at speeds of 210 to 240 kilometres per hour. The winds and rain, combined with the force of the sea, produce huge waves. These waves, called a *storm surge,* rise several feet above normal and cause floods. A storm surge can be especially destructive if it occurs at high tide. Also, tornadoes are often present in hurricane clouds.



Hurricane winds rotate around the *eye,* a calm area in the centre of the storm. This photograph was taken from the space shuttle *Discovery* in 1985. It shows the wall clouds, which surround the eye, and the other whirling rain clouds. The arrow indicates the direction of the winds.

Famous hurricanes of the 1900's

1900	A hurricane and storm surge killed about 6,000 people in the Galveston, Texas, U.S.A. area.
1928	About 1,800 people died in a hurricane and floods in the Lake Okeechobee area of Florida, U.S.A. The storm also killed 300 people in Puerto Rico.
1935	The barometer fell to 66.93 centimetres during a hurricane that struck Tampa, Florida, U.S.A. This was the lowest reading ever recorded in the Western Hemisphere. Over 400 people were killed in the storm.
1938	A hurricane tore through Long Island and New England, U.S.A., killing about 600 and causing U.S. $400 million in damage.
1955	Hurricane Diane caused about U.S. $$1\frac{3}{4}$ billion in damage from North Carolina to New England, U.S.A., and killed 184 people.
1957	Hurricane Audrey struck Louisiana, Mississippi, and Texas, U.S.A., killing 550 people.
1960	Hurricane Donna became the first recorded storm to strike not only Florida, but also the Middle Atlantic States, and the New England States of the U.S.A. with hurricane-force winds.
1963	Hurricane Flora killed about 5,000 people in Haiti, over 1,700 in Cuba, and over 400 in the Dominican Republic.
1965	Hurricane Betsy killed 76 people and caused more than U.S. $1 billion in damage in the Bahamas, and in southern Florida, and Louisiana, U.S.A.
1967	Hurricane Beulah hit Caribbean islands, Mexico, and Texas, U.S.A., causing 58 deaths and over U.S. $1 billion in damage.
1969	Hurricane Camille killed more than 250 people in seven U.S. states from Louisiana to Virginia. It caused about U.S. $$1\frac{1}{2}$ billion in damage.
1972	Floods of Hurricane Agnes killed 122 people and caused U.S. $3 billion in damage from Florida to New York.
1974	Hurricane Fifi struck Honduras, killing about 8,000 people and causing U.S. $1 billion in damage.
1979	Hurricane David battered the Dominican Republic, killing 1,200 and causing U.S. $1 billion in damage. Hurricane Frederic struck Alabama and Mississippi, U.S.A., killing 8 and causing U.S. $$1\frac{1}{2}$ billion in damage.
1983	Hurricane Alicia struck Texas, killing 21 people and causing U.S. $2 billion in damage.
1988	Hurricane Gilbert, the most powerful hurricane ever recorded in the Western Hemisphere, struck the West Indies and Mexico, causing about 300 deaths.
1989	Hurricane Hugo struck the West Indies and the Southeastern United States, causing 60 deaths and U.S. $7 billion in damage.
1992	Hurricane Andrew struck the Bahamas, southern Florida, U.S.A., and Louisiana, U.S.A., causing 52 deaths and an estimated U.S. $22 billion in damage.

When a hurricane moves over land, strong winds and heavy rain hit the area for several hours. As the eye reaches the area, the rain stops and the air becomes calm. Less than an hour later, the eye passes and the rain and wind return. The hurricane weakens as it moves over land because it needs the warm sea to supply energy by evaporation. Friction caused by the rougher land surface also helps to slow the winds. Heavy rain continues even after the winds decrease.

Hurricane warnings. During the hurricane season, meteorologists keep a close watch on the Atlantic and Pacific oceans, particularly on the Caribbean Sea and the Gulf of Mexico. They also examine pictures of the area taken by weather satellites and collect such information as air pressure, temperature, and wind speeds. They use this information to forecast where a hurricane will hit and how strong it will be. They track the storm with satellites, aeroplanes, and radar. Weather centres then issue warnings to communities in the storm's path.

See also **Cyclone; Flag** (Signal flags; picture: Hurricane warning); **Tornado; Typhoon; Weather.**

Hus, John (1369?-1415), was a Bohemian religious reformer. His name is also spelled *Huss.* Hus's teachings resembled some of those of the Protestant Reformation.

Hus was born in Husinec, a town in southwestern Bohemia. Soon after he was ordained in 1400, he began preaching fiery sermons in Prague. He attracted many followers, especially Czech nationalists. Hus attacked the morals of the clergy and called for reform in the church. He was influenced by the works of John Wycliffe, an English religious reformer of the 1300's. Unlike Wycliffe, Hus did not attack the sacrament of the Mass.

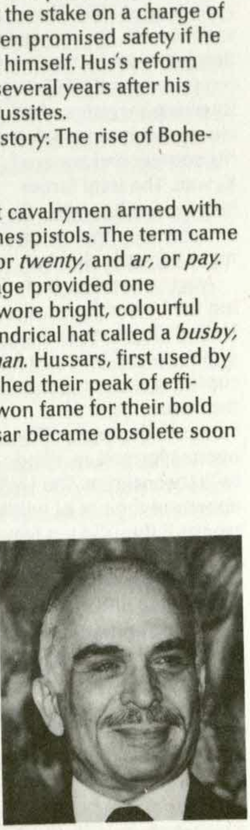
In 1409, the king of Bohemia turned the University of Prague over to the Czechs, and Hus became rector. This action angered the German teachers and students at the university. They left and established the University of Leipzig. The Germans spread the story that Hus was a notorious heretic. In 1413, Hus completed *On the Church,* a highly spiritualized view of the church that borrowed heavily from Wycliffe's writings. In 1414, Hus was called before the Council of Constance, a meeting of church leaders at Constance, Germany. There he was condemned, largely for the ideas expressed in *On the Church.* He was then burned at the stake on a charge of heresy, even though he had been promised safety if he attended the council to defend himself. Hus's reform movement was carried on for several years after his death by followers known as Hussites.

See also **Czechoslovakia** (History: The rise of Bohemia); **Wycliffe, John.**

Husky. See **Siberian husky.**

Hussars were European light cavalrymen armed with carbines, swords, and sometimes pistols. The term came from the Magyar words *husz,* or *twenty,* and *ar,* or *pay.* Every twentieth house in a village provided one mounted soldier. The hussars wore bright, colourful uniforms, including a high cylindrical hat called a *busby,* and a loose cape called a *dolman.* Hussars, first used by the Magyars in the 1400's, reached their peak of efficiency under Napoleon. They won fame for their bold and reckless fighting. The hussar became obsolete soon after World War I (1914-1918).

Hussein I (1935-) became king of Jordan in 1952. He succeeded his father, Talal, and developed Jordan's economy with aid from Western countries. Hussein kept peace with Israel, until Israel destroyed the Jordanian village of As Samu in 1966. He took part in the 1967 and 1973 Arab-Israeli wars. During the 1967 war, Hussein's air force was destroyed, and Israel occupied the territory in Palestine called the



Hussein I

West Bank, which Jordan had annexed in 1950. As a result, many West Bank Palestinians fled to eastern Jordan. Eventually, Palestinian refugee guerrillas became so powerful that they threatened to overthrow Hussein and his government. Hussein's strong stand against the guerrillas in Jordan led to civil war in 1970. In 1974, Hussein gave up Jordan's authority over the West Bank but continued to give it financial and administrative support. In 1988, he ended Jordan's role in the area and called for the Palestine Liberation Organization (PLO) to take over.

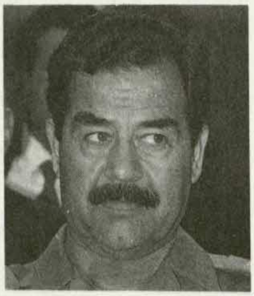
In 1990, Iraq invaded and occupied Kuwait. Western and Arab countries formed an alliance and drove the Iraqis out of Kuwait in 1991. Hussein remained neutral in the conflict, and Jordan's relations with Arab countries in the alliance became strained. In July 1994, Hussein and Israeli Prime Minister Yitzhak Rabin signed a declaration that marked the end of a state of war that had technically existed between Jordan and Israel since 1948.

Hussein was born in Amman.

Hussein, Saddam (1937-), has been president of Iraq since 1979. He is chairman of the Revolutionary Command Council of the Baath Party, which sets government policies. Using Iraq's petroleum resources, Hussein supervised a successful development programme. This was halted by a war with Iran from 1980 until 1988, when a cease-fire was declared. Hussein became known for his ruthless actions. For example, in the 1980's, he used chemical weapons against Kurdish people of Iraq, who were seeking self-government.

In August 1990, Hussein ordered Iraqi forces to invade Kuwait. He accused Kuwait of violating oil production limits set by the Organization of Petroleum Exporting Countries (OPEC), thus lowering the price of oil. Hussein announced that his country had annexed Kuwait. The Iraqi forces killed many Kuwaitis, destroyed property, and set many oil wells alight.

Many countries, including the United States, the United Kingdom, and several Arab and Western European nations, opposed the invasion and sent forces to the region. These nations formed an allied military coalition. The United Nations Security Council approved the use of military force to remove the Iraqi troops if they did not leave Kuwait by Jan. 15, 1991. Hussein refused to withdraw his troops, and war broke out on January 17 (Iraqi time). The allies bombed military targets in Iraq and Kuwait, and Iraq launched missiles against Saudi Arabia and Israel. In February, allied land forces moved into Kuwait. They quickly defeated the Iraqi forces. For more details, see **Persian Gulf War**. Hussein's government failed to fulfil the terms of a cease-fire agreement. The United Nations maintained a trade embargo on Iraq, seriously harming the country's economy (see **Iraq** [Recent developments]).



Saddam Hussein

Hussein was born in Tikrit. He became active in the Baath Party in 1956. In 1959, Hussein left Iraq after he took part in an attempt to kill Iraqi dictator Abdul Karim Kassem. He was imprisoned in 1964, after he returned to Iraq. He had been elected to the Regional Command of the Baath in 1963. In 1965, while in prison, he was elected to the National Command. Hussein escaped from jail in 1966. The Baath took control of Iraq in 1968.

Hussein, Taha (1889-1973), an outstanding Egyptian writer, overcame poverty and blindness to become a leading literary and public figure. He served as minister of education in 1951 and 1952.

Hussein's masterpiece, a three volume autobiography, was the first modern Arabic literary work to be widely translated. The books are *An Egyptian Childhood* (1926), *The Stream of Days* (1932), and *A Passage to France* (1967).

Taha Hussein was born in a village in southeastern Egypt. Despite his handicaps, he was the first graduate of Egypt's first modern university. He became the first Egyptian dean of the faculty of arts at his university. He was also the first Egyptian to be nominated for the Nobel Prize for literature.

Hussein bin Onn, Datuk (1922-), was the third prime minister of Malaysia from 1976 to 1981.

Hussein was born in Johor. His father and grandfather were both chief ministers of Johor. Hussein was educated at the English College in Johor Bahru and later attended a military academy in India. In 1942, he joined the Indian Army. He served in the Middle East during World War II (1939-1945). He joined the British forces to liberate Malaya from the Japanese in 1945.

Both Hussein and his father Dato Onn bin Ja'afar played an important part in the formation of United Malays National Organization (UMNO) in 1946. They fought against British proposals to form a Malayan Union, which would have made Malaya a British colony. Onn Ja'afar became president of UMNO and Hussein was its secretary-general and youth leader.

In 1951, they resigned from UMNO because of policy differences. Hussein then left for London to study law. He returned as a barrister. Hussein rejoined the party in 1968. In 1969, he was elected to parliament. From 1973 to 1976, he served under Tun Abdul Razak as deputy prime minister. When Abdul Razak died in 1976, Hussein became prime minister.

Husseini, Hajj Amin al- (1897-1974), was the *grand mufti* (Islamic religious head) of Jerusalem. He became one of the main leaders of the Arab movement in Palestine during the 1920's and 1930's. He led attempts to resist the growth of Zionist power in Palestine. See **Palestine and Zionism.**

Hajj Amin al-Husseini was born in Jerusalem. In 1921, the British appointed Husseini president of the newly-created Supreme Muslim Council. In 1936, he managed to unite opposing groups into the Arab High Committee under his chairmanship. He opposed Jewish immigration, and demanded an end to the transfer of land from Arabs to Jews. Husseini helped to organize a general strike to back these demands. The British took this action as a challenge to their authority, and outlawed the Arab High Committee. Husseini fled to Syria and later lived in Iraq, Germany, and Egypt.

Hussey, Gemma (1940-), became, in 1982, the first female minister of education in the Republic of Ireland. She held that office until 1986, when she was appointed minister of social welfare. A Fine Gael politician, she ceased to be a minister when the coalition government was defeated in a general election in 1987. Hussey was a Senator from 1977 to 1982, when she was first elected to *Dáil Éireann* (the Irish House of Representatives) for the Wicklow constituency.

Hussites were followers of the Bohemian religious reformer John Hus. They were organized by about 450 nobles to avenge the killing of Hus in 1415 (see **Hus, John**). The most prominent Hussite conflict with the Roman Catholic Church concerned the administering of communion. But, because of political, social, and religious differences that existed before Hus's death, the Hussites broke into two main groups. The moderates, called Ultraquists, agreed to discuss religious issues with the church at the Council of Basel in 1433 and won a concession on communion. The more radical Taborites refused to negotiate with the church or to accept the nobles' political control. The Taborites fought the armies of Emperor Sigismund and the forces of the church and Ultraquists from 1419 until the Taborites were finally defeated in 1434.

Huston is the family name of two film personalities—Walter, an actor; and his son John, a screenwriter and director. They made one film together, *The Treasure of the Sierra Madre* (1948). The film earned Walter an Academy Award as best supporting actor and John Academy Awards for screenplay and directing.

Walter Huston (1884-1950) was born in Toronto, Canada, and became a U.S. citizen in 1922. Huston toured in vaudeville, and starred in such Broadway plays as *Desire Under the Elms* (1924) and *Knickerbocker Holiday* (1938). His movies include *Rain* (1932), *Yankee Doodle Dandy* (1942), and *Duel in the Sun* (1946).

John Huston (1906-1987) won fame for directing films that have a sense of brooding atmosphere. The first film he directed was *The Maltese Falcon* (1941), a classic detective story. He also directed *Key Largo* (1948), *The Asphalt Jungle* (1950), *The Red Badge of Courage* (1951), *The African Queen* (1951), *Beat the Devil* (1953), *Moulin Rouge* (1953), *Moby Dick* (1956), *Fat City* (1972), *Under the Volcano* (1984), *Prizzi's Honour* (1985), and *The Dead* (1987). Huston was born in Nevada, Missouri. He gave up his U.S. citizenship and became an Irish citizen in 1964. He wrote *An Open Book* (1980), his autobiography. Anjelica Huston, his daughter, won the 1985 Academy Award as best supporting actress for her performance in *Prizzi's Honour.*

Hutchins, Robert Maynard (1899-1977), an American educator, became well known for his unconventional theories about higher education. In 1929, he was appointed president of the University of Chicago. He became chancellor in 1945. At Chicago, he promoted intellectual rather than narrow moral considerations as the primary aim of higher education. He reduced the emphasis on athletics. He served as associate director of the Ford Foundation from 1951 to 1954. Hutchins served as president of the Fund for the Republic from 1954 to 1969 and as chairman from 1969 to 1974. He was chairman of the board for a new edition of the *Encyclopaedia Britannica,* which was published in 1974.

Hutchins was born in Brooklyn, New York, and graduated from Yale University. He served as secretary of Yale from 1923 to 1927. In 1928, he became dean of the Yale Law School.

Hutchinson, Anne Marbury (1591-1643), headed a group of Puritans whose religious beliefs were unacceptable to Puritan leaders of the Massachusetts Bay Colony in the United States. Her teachings caused deep divisions in the colony between 1636 and 1638.

Anne Marbury was born in Alford, Lincolnshire, England. She married William Hutchinson in 1612. In 1634, the Hutchinson family moved to the Massachusetts Bay Colony. There, Anne joined the congregation in Boston. She began holding religious meetings in her home, where she interpreted church teachings in ways that Puritan leaders considered dangerous. For example, Hutchinson preached that nothing people could do by choice, including obeying church and state law, could win God's love and favour. She also said that God communicated to people directly instead of through public and church officials. Hutchinson and her followers were called *Antinomians*, meaning people who are against law.

Massachusetts officials ordered Hutchinson to leave the colony in 1637, and the church expelled her in 1638. She moved with her family to Rhode Island, and then to New York after her husband died in 1642. She and several members of her family were murdered there by Indians in 1643.

Hutchinson, Thomas (1711-1780), was one of the last royal governors of the Massachusetts Bay Colony. His refusal to let the tea ships leave Boston Harbor led to the Boston Tea Party in 1773 (see **Boston Tea Party**). He was just and able, but he became the symbol of royal power to colonists seeking independence.

Hutchinson, born in Boston, was the son of a wealthy merchant. He graduated from Harvard College in 1727, and entered his father's business. He was elected to the Boston board of selectmen and the general court of Massachusetts in 1737, and became chief justice of the colony in 1760.

Hutchinson issued the famous and unpopular writs of assistance (see **Writ of assistance**). He opposed the Stamp Act, but declared it legal and tried to enforce it. In 1765, angry colonists burned his house. He became acting governor in 1769 and governor in 1771.

After the Boston Tea Party, Hutchinson went to England. He advised King George III, and continued writing his important *History of the Colony and Province of Massachusetts Bay.*

Hutterites, also called Hutterian Brethren, are members of a North American religious sect who believe in the common ownership of goods. They follow the example of the early Christians who "had all things common" (Acts 2: 44). They do not believe in war or violence. They live in *Bruderhofs* (colonies) of about 85 persons. About 320 Bruderhofs are in South Dakota, Montana, and the prairie provinces of Canada.

The Hutterites are farmers who lead simple lives. They meet daily for worship. A preacher and a *Wirt* (boss), who is the financial manager, head each colony. The group maintains its own kindergarten and school.

The Hutterites originated in 1528 in Moravia as a branch of the Anabaptists. They were named after Jacob Hutter, who was their leader from 1533 until 1536 when he was burned at the stake. The Hutterites were severely persecuted. After 1564, they prospered in Moravia. But in 1595, they were driven to nearby countries and to the

Ukraine in the Soviet Union. They settled in the United States in 1874. Many migrated to Canada in 1918. About 9,000 Hutterites live in the United States and 18,000 live in Canada.

See also **Anabaptists.**

Hutton, James (1726-1797), a Scottish geologist and doctor, became famous for theories on the earth's origin. He is called the father of modern geology.

According to one of Hutton's theories, heat played an important part in the formation of the earth. He believed that rocks of basalt and granite were formed from a molten mass. Most other scientists thought that water had once covered the earth and that all rocks were formed when minerals settled at the bottom of the water. Hutton also theorized that the earth changed gradually by natural processes and would continue to change through the same processes. Other scientists believed that the earth was completely formed about 6,000 years ago and that only rare catastrophes could change its features.

Hutton was born in Edinburgh and studied in Edinburgh, Paris, and Leiden, in the Netherlands. See also **Geology** (History).

Hutton, Sir Leonard (1916-), was captain of the England cricket team and a brilliant opening batsman. He began playing for Yorkshire in 1934 and made the first of 70 Test match appearances for England in 1936. At 22, he scored 364 runs in a match against Australia. His score was then a record for a Test match. In 1952, he became England's first professional captain of the 1900's. In 1953, he led the England team that regained the *Ashes.* He retired in 1956. During his career, Hutton made more than 40,000 runs.

Huxley is the family name of three distinguished British scientists and writers.

Thomas Henry Huxley (1825-1895) was a famous zoologist, lecturer, and writer. He was one of the first to be convinced by Charles Darwin's analysis of organic evolution, and he extended and defended it (see **Darwin, Charles R.**). Through his lectures, writings, and committees, Huxley helped advance scientific thought.

His writings include *Evidence as to Man's Place in Nature* (1863), *Critiques and Addresses* (1873), and *A Manual of the Anatomy of Invertebrated Animals* (1877). His essay "On a Piece of Chalk" (1868) is an outstanding presentation of the evidence for evolution to a nonscientific audience.

Many of Huxley's expressions became famous. He introduced the word *agnostic* to describe one who believes that the existence of God or a spiritual world cannot be proved. He coined the word *biogenesis* to emphasize that life arises only from previous life (see **Biogenesis**).

Huxley was born near London, and studied by himself until he entered medical school. He became a surgeon in the British navy and spent four years in the Indian Ocean and East Indies. He wrote a pioneering account of jellyfish, and returned to England to find that he had become famous. From 1854 to 1885, he taught history at the Royal School of Mines. He served as president of the Royal Society from 1881 to 1885.

Sir Julian Sorell Huxley (1887-1975), a grandson of Thomas Huxley, became a noted biologist. He did research in *ornithology* (the study of birds) and on the experimental analysis of development. He made a study of the relative rates of growth of bodily organs and developed a mathematical method to analyse body proportions. In 1946, Huxley helped establish the United Nations Educational, Scientific and Cultural Organization (UNESCO). He was elected its first director-general in 1946. In 1958, Huxley was knighted for his contributions to science.

Huxley's writings include *Essays of a Biologist* (1923); *The Science of Life* (with H. G. and G. P. Wells, 1929-1930); *Problems of Relative Growth* (1932); *Elements of Experimental Embryology* (with G. R. de Beer, 1934); *Evolution, the Modern Synthesis* (1942); *Man in the Modern World* (1947); *Essays of a Humanist* (with H. B. Kettlewell, 1964); and several poems.

Huxley was born in London. He taught at Rice Institute in Texas, U.S.A., from 1912 to 1916. He later became a professor at King's College, London.

Aldous L. Huxley

Aldous Leonard Huxley (1894-1963), the brother of Julian Huxley, had one of the most varied literary careers of his time. He published three collections of poems and a book of short stories before beginning the series of witty, sophisticated novels that made him famous. The series includes *Crome Yellow* (1921), *Antic Hay* (1923), *Those Barren Leaves* (1925), and *Point Counter Point* (1928). The books satirize English society of the 1920's. The characters in *Point Counter Point* are based on Huxley and his friends.

Huxley believed science was destroying human and political values. He expressed this concern in the satirical novel *Brave New World* (1932). This famous book describes a totalitarian society that disregards individual dignity and worships science and machines.

Huxley was born in Godalming, Surrey. He moved to the United States in the late 1930's, and spent most of the rest of his life there.

Huygens, Christiaan (1629-1695), was a Dutch physicist, astronomer, and mathematician. In 1678, Huygens proposed that light consists of series of waves. He used this theory in investigating the *refraction* (bending) of light. Huygens' wave theory competed for many years with the *corpuscular theory* of the English scientist Isaac Newton. Newton maintained that light is made up of particles. Today, scientists believe that light behaves as both a particle and a wave.

Huygens was born in The Hague. He studied mathematics and law at the University of Leiden and the College of Orange at Breda. Huygens worked with his brother Constantijn to develop skill in grinding and polishing spherical lenses. With these lenses, they built the most powerful telescopes of their time. Huygens also discovered a satellite of Saturn and asserted that what astronomers called "Saturn's arms" was a ring around the planet. In mathematics, he refined the value of *pi* (see **Pi**). In the 1650's, Huygens invented a clock with a freely suspended pendulum.

See also **Light** (Early ideas about light).

Hyacinth is a favourite spring flower of the lily family. It originated in the Mediterranean region and *Asia Minor* (now Turkey), and was brought to western Europe in the early 1500's. It is a popular plant in many parts of the world. The bell-shaped flowers of blue, pink, white, yellow, or purple, bloom from February to April on stalks which grow from 20 to 40 centimetres high.

Hyacinths grow from bulbs. They can be planted in open beds, greenhouses, and in the home. When grown in the open, they need rich, well-drained soil. The bulbs are planted from September to November, depending on the climate.

Early in the spring, the flowers appear. Gardeners sometimes tie the stems to slender stakes to protect them from damage. After the plant flowers, gardeners remove the stalks and let the leaves die. This encourages new bulb growth. Florists pot specially treated bulbs early in September to force the plants to blossom by Christmas.

The hyacinth is a spring flower that grows from a bulb. It produces small, fragrant, bell-shaped flowers on a slender stalk.

The soil and climate of the Netherlands provide an especially favourable place for growing the bulbs. The Dutch plant a large number of hyacinths every year near Haarlem. They ship the bulbs to many parts of the world for gardeners and florists to use.

Scientific classification. Hyacinths belong to the lily family, Liliaceae. The common hyacinth is *Hyacinthus orientalis.*

See also **Bulb; Flower** (picture: Garden perennials [Bulbs]).

Hyaline membrane disease. See **Respiratory distress syndrome.**

Hybrid is the offspring of parents of different races, varieties, or species. Hybrids occur naturally and contribute to the great variety of living things. However, the term *hybrid* is used most often to refer to crops and ornamental plants bred by human beings.

Hybrid plants are extremely important in agriculture. Most maize and sorghum is grown from hybrid seed. Most commercial varieties of sugar beet are hybrids, as are some varieties of alfalfa, barley, rice, and wheat. Vegetables produced from hybrid seed include broccoli, cabbage, carrots, cauliflower, melons, onions, peppers, pumpkins, and tomatoes. Hybrids of such fruits as grapes, pears, and plums are also grown. Many marigolds, orchids, petunias, roses, and other flowers that beautify homes and parks are hybrids.

Some hybrid animals are also bred, but animal hybrids have been less commercially successful than plant hybrids. In most cases, the parents of animal hybrids are members of the same large hereditary group, called a *family,* but belong to a different *genus* (subgroup of a family) or *species* (subgroup of a genus). Animal hybrids include mules, which are bred from female horses and male donkeys; and cattaloes and beefaloes, the offspring of cattle and American buffaloes. The remainder of this article deals with plant hybrids.

Producing hybrids. People produce hybrids in order to improve the quality and productivity of cultivated plants. Plants selected for hybrid production have hereditary characteristics that growers want to continue into future generations. For example, one variety of maize may resist disease better than another variety does. But the second variety may be hardier in cold weather than the first. By *crossing* (mating) the two varieties, growers can obtain hybrid seeds. These seeds develop into plants that have the traits of both parents. Seed from the hybrid offspring, however, produces plants of varying quality. Some hybrids may also be *sterile* (unable to reproduce). As a result, growers plant new hybrid seed each year to maintain the quality of their crops.

Most flowering plants have both male and female sex parts, contained either in separate flowers or in the same flower. To ensure that only certain plants cross, growers select some to serve as males and some as females. They generally remove the male sex parts, which produce pollen, from the plants that will act as females, thereby preventing the plants from pollinating themselves or other females. In some cases, they use female plants that have been specially bred to produce infertile pollen. The male plants are untouched.

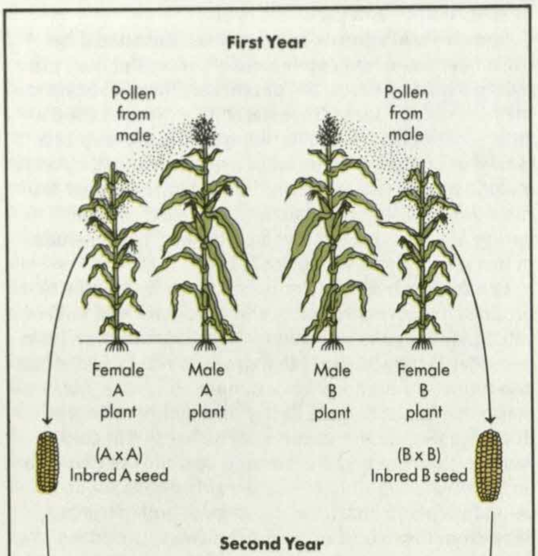
The hybrid seed produced from the crossing of selected parents is often the result of a long and complicated process. Maize growers, for example, first cause selected maize plants of the same variety to breed. This procedure of breeding from closely related plants is called *inbreeding.* The seeds produced from the inbred plants are planted, and the plants that grow from them are in turn forced to inbreed. This process continues through several generations until plants having pure hereditary lines are established.

Growers then cross two inbred varieties. They remove the *tassels* (male maize flowers) from the plants chosen as females, leaving the *ears* (female maize flowers) for pollination by the inbred males. The seed resulting from this breeding produces *single-cross hybrids.* These plants combine the hereditary characteristics of two inbred varieties.

History. Many different kinds of hybrid plants were described by naturalists during the 1700's and 1800's. In 1922, hybrid seed maize was sold to farmers for the first time. By the mid-1940's, nearly all the maize planted in major maize-growing areas was hybrid maize. During

Producing hybrid maize

Most hybrid maize results from *single-crossing.* In this process, selected maize plants are forced to breed with other plants of the same variety. This procedure produces *inbred seed.* Two inbred varieties are then bred, resulting in single-cross seed.



the 1960's, hybrids became important for other kinds of crops.

See also **Breeding** and its list of *Related articles.*

Hydatids are cysts that contain a watery fluid. They occur in the tissues of people, sheep, and some other animals. Hydatids are formed by and contain tapeworm larvae. Hydatid disease is dangerous to human beings. Dogs may carry the disease. If a dog comes in contact with sheep's offal that contains the cysts, tapeworm larvae may cling to the dog's hair. People may then pick up the disease by handling the dog. For this reason, people should wash their hands after handling a dog. People may also get the disease by eating raw vegetables or drinking contaminated water. In sheep-rearing countries, the disease presents a major health problem.

Hyde, Douglas (1860-1949), served as the first president of Eire (now the Republic of Ireland) from 1938 to 1945. Hyde was a Gaelic scholar and helped to found the *Gaelic League,* an organization set up to revive the widespread use of Gaelic and to encourage the study of Irish literature.

Hyde wrote his best-known work, *A Literary History of Ireland,* in 1899. He also wrote poems, plays, and works on history and folklore. In *Beside the Fire* (1890), Hyde collected Irish folklore, and also set down ideas concerning the literary use of folk language.

Hyde was born in County Roscommon and was educated at Trinity College, Dublin. He was professor of Irish at the National University (1909-1932).

Hyde Park. See **London.**

Hyde Park Barracks is located at the southern end of Macquarie Street in Sydney, Australia. The building was originally designed by the architect Francis Greenway to house convicts. It was opened by Governor Lachlan Macquarie on June 4, 1819. From 1848, the building was used as an immigration depot and as an asylum for infirm women. In 1880, it was converted into a district court. In 1975, work began to restore the building and to convert it into the Museum of the History of Sydney and New South Wales. A team of researchers spent six months searching beneath the floor boards to discover personal possessions of the convicts and of the women who lived there in the 1840's. The museum now has exhibits showing how the convicts lived. One room has been restored to show how convicts slept in hammocks slung from the rafters. Other exhibits are designed to represent life in Sydney, past and present.

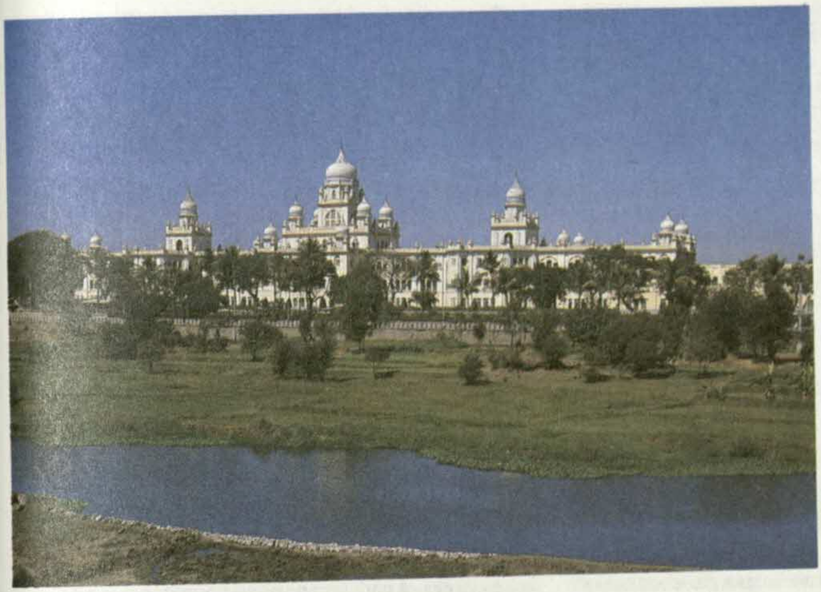
See also **Greenway, Francis.**

Hyderabad is a large historic region in India. It became a state of India in 1950. In 1956, India reorganized its states and divided Hyderabad among the states of Bombay (now Gujarat and Maharashtra), Mysore (now Karnataka), and Andhra Pradesh. Hyderabad covered 214,187 square kilometres in southern India and had a population of over 18 million.

Hyderabad was part of the Mughal Empire from 1687 to 1724. Then a Mughal *viceroy* (governor) made it independent. During the 1800's, Britain gained control of Hyderabad's foreign affairs. The *Nizams* (rulers) of Hyderabad were famous for being among the richest people in the world. Although the Nizams were Muslims, four-fifths of their subjects were Hindus.

When India was partitioned in 1947, the Nizam refused to join either Pakistan or India. Clashes followed between Muslims and Hindus. In 1948, India set up a military government in Hyderabad. When Hyderabad State was partitioned, Hyderabad City became the capital of the state of Andhra Pradesh.

Hyderabad (pop. 3,091,718; met. area pop. 4,273,498), an important centre of trade, is one of India's largest cities. Founded in 1589 by the Muslim Sultan Muhammad Quli as a royal capital, it was the capital of the state of Hyderabad from 1950 to 1956. It then became the capital of Andhra Pradesh. It is situated on the Musi River about 500 kilometres northwest of Madras and 600 kilometres southeast of Bombay. For location see **India** (political map).



Osmania Hospital, on the bank of the Musi River in Hyderabad, was built by Sultan Muhammad Quli in the 1500's

The city

The old city of Hyderabad is built on either side of the Musi River. Most of the buildings of special interest are located within the walls of the old city. The newer twin city of Secunderabad is located to the north of Hyderabad on the shores of the Hussain Sagar Lake.

Buildings. In the centre of the old walled city of Hyderabad is the huge triumphal arched gate called the *Charminar* (Four Towers) built by the Muslim ruler Muhammad Quli Qutab Shah in 1591 to celebrate the end of a plague in Hyderabad. The building has four *minarets* (towers) and four arches through which the main streets of the city pass. The building, made of stone and mortar, rises nearly 50 metres above the base on which it rests.

Next to the Charminar is the Mecca Masjid, one of the largest mosques in the world. It can accommodate more than 10,000 worshippers. Construction began during the reign of Muhammad Quli Qutab Shah. But the building was not completed until 1687. According to records, the massive slabs of granite that make up the colonnades and door arches were dragged to the site, from a quarry 10 kilometres away, by a team of 1,400 bullocks.

The ruins of Golconda Fort are located about 10 kilometres west of the centre of Hyderabad. Built of granite, the fort covers a whole hillside. It was an administrative centre and market place. Golconda served for many years as a diamond market for nearby mines. The fort was built mainly during the 1500's and 1600's when the Muslim Qutab Shahi kings ruled the city. But the origins of the fort have been traced to earlier Hindu periods. Birla Mandir Temple is a modern Hindu temple built overlooking Hussain Sagar Lake. It is a popular Hindu pilgrimage centre.

People

Hyderabad is a densely populated city. It is an important centre of Islamic culture.

Education and culture. Hyderabad has many museums and colleges. Osmania is the best known of its three universities. Among several research institutes are the Abdul Kalam Azad Oriental Research Institute, the Institute of Asian Studies, and the Henry Martin Institute of Islamic Studies. Research is also carried on into such subjects as geophysics, heavy chemicals, and nutrition. Outstanding libraries include the State Central Library and the Oriental Manuscript Library.

Religion and language. Hindus make up nearly two-thirds of the population, and Muslims almost one-third. Christians and others form a tiny minority.

Almost half the people speak Telegu, the main language of the state. About 37 per cent of the people speak Urdu, and about 15 per cent speak other languages. The educated classes also speak and understand English.

Economy. Hyderabad is a trading centre, and also has factories producing flour, glassware, guns, paper, railway rolling stock, and textiles. There are four main industrial districts. Asamabad is the centre for chemicals and cigarettes. In Sanat Nagar and Kojat Palli, factories produce metalwork, refrigerators, and watches. Maula Ali and Nacharam specialize in biscuits, chemicals, and pharmaceutical products. Heavy electrical equipment and electronics are produced in Ramachandra Puram.

Transport. Hyderabad is an important trading centre. The city is served by road, rail, and air services to Bombay, Calcutta, Delhi, and Madras.

Government. As capital of Andra Pradesh, Hyderabad is the home of the 294-seat state legislative assembly. Hyderabad city is also the headquarters of the administrative district of Hyderabad. Services needed to run the daily life of the city are provided by a municipal council.

History

Hyderabad city was founded in 1589 as a royal capital by Sultan Muhammad Quli, the fifth ruler of the Qutab

Shahi dynasty of Golconda. He selected the site for the city near to a village called Chiclam, which he later renamed Bhagnagar (present-day Yaqut-pura). The city was laid out according to classical Hindu plans. But the socially important inhabitants were Muslims, so, instead of the traditional Hindu temple, the architects built the Charminar in the city centre.

To the northeast, on the banks of the Musi River, the sultan built a mosque, a hospital, medical college, and a large inn which provided accommodation for *caravans* (groups of travellers and their animals). Various bazaars developed, each with its own functions. The western Lad bazaar, for example, sold cosmetics and jewellery, especially bangles. Plans were developed for the building of 7,000 shops.

The city became a cosmopolitan centre for artists, scholars, poets, and traders, who flocked to it from China, the Middle East, Persia, Russia, and Western Europe. The Mughals conquered the city in 1687, and it lost most of its former glory.

A hundred years later, Hyderabad's fortunes improved when its rulers concluded a series of treaties, first with the French, and later with the British East India Company. An administrator, known as a *resident,* was established and soon afterwards the residency was built to the north of the Musi River. The first resident, James Achilles Kirkpatrick, moved into the building about 1795. Today it serves as Osmania University Women's College. A new city sprang up, centred on the Residency, and farther north a third city was developed where the Russell Brigade was billeted. This entire area (today's Secunderabad) was European in style. It retained its separate identity until India's independence in 1947, when the British handed over its administration to the *Nizam* (local ruler).

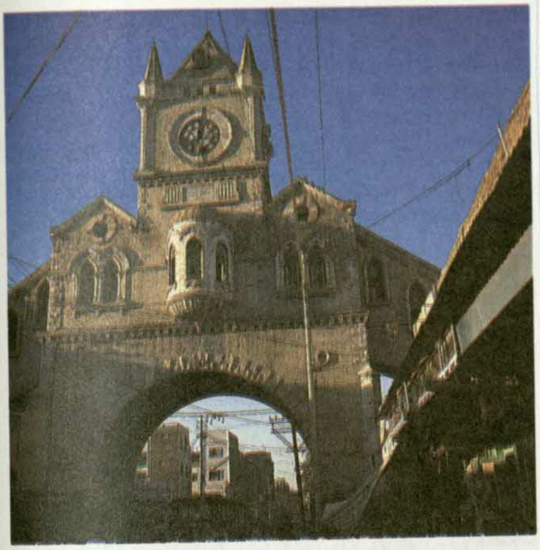
In 1948, the federal government of India annexed the Nizam's state of Hyderabad. In 1956, the state, which had three official languages, was split into three linguistic sections. The five Marathi-speaking districts were merged with the state of Maharashtra; the three Kanarese districts joined Karnataka; and the nine Telegu districts merged with Andhra to form the state of Andhra Pradesh, with Hyderabad city as the capital.

In 1919, Hyderabad city covered an area of more than 170 square kilometres and could accommodate about half a million people. But from then on, more and more people flocked to the city from the coastal districts and created a serious housing problem. To cope with this, a new master plan was designed in 1975 and the city has now expanded to cover an area of 562 square kilometres.

A third of the city is made up of protected *green zones* (areas of parkland or open country preserved from urban development). Residential areas are separated from industrial and commercial zones. Several new bridges span the Musi River, and inner and outer ring roads have eased traffic problems.

See also **Andhra Pradesh.**

The Charminar stands at the centre of the old city of Hyderabad. The two main streets of the city cross beneath the arch.



The clocktower arch in Hyderabad stands in the city's huge *bazaar* (market place). It was built by the British after they took control of the Sind in 1843.

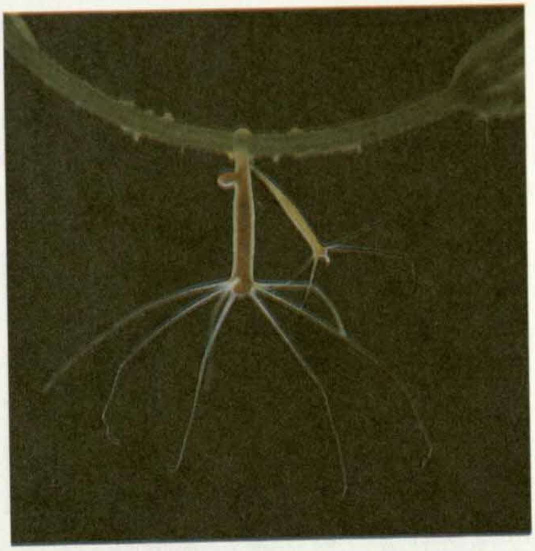
Hyderabad (pop. 751,529) is a city in the Sind province of Pakistan. It lies on the banks of the Indus River. For location, see **Pakistan** (political map). Hyderabad is a rail and road junction and an important trade centre. The railway runs north to Peshawar and south to Karachi. The University of Sind lies on the west bank of the Indus. There are also several government colleges and the Liaqat Medical College. Industries include cotton ginning, rice and oilseed milling, tanning, and the manufacture of agricultural machinery and cement. The city is famous for its hand embroideries and leatherwork. Sarfaraz Khan built the city in 1782 as a fort.

Hydra is a tiny, slender animal that lives in ponds and lakes. Hydras are *cnidarians,* a group that also includes jellyfish, sea anemones, and corals.

The hydra has one of the simplest structures of the many-celled animals. It is shaped like a thin cylinder about as thick as heavy thread and is 6 to 13 millimetres long. A hydra may be grey, tan, brown, or green. The green hydra gets its colour from algae that live in certain cells of its body wall.

One end of a hydra's body attaches to sticks, stones, and water plants. The other end contains the mouth, which is surrounded by five to seven *tentacles* (tiny arms). The hydra can stretch out or contract its entire body. Sometimes it stretches its tentacles until they look like long, delicate threads. At other times, it pulls in its tentacles. Then its body looks like a tiny egg with a group of knobs on the end. The hydra usually stays attached in one place for some time. But it can move about by slowly somersaulting on the bottom of the pond or lake, or by drifting upside down beneath the water's surface film.

A hydra eats other small water animals that it captures with its tentacles. Each tentacle has tiny cells that contain stinging threads. The hydra drives these threads into its prey, and they give off a poison that paralyses the victim. Then the tentacles draw the victim into the mouth to be swallowed. The hydra's mouth is a small opening leading directly into a large digestive cavity inside the body. The undigested remains pass out through the mouth.



The hydra usually begins life as a bud that grows on the body of its parent, *above.* When fully developed, the young hydra detaches itself and lives independently.

Hydras usually reproduce by *budding. Buds* are small, knoblike growths that appear on the body of the hydra from time to time. As the buds develop, they grow tentacles. When the buds are fully developed, they break off and live as independent hydras. Hydras also may produce eggs and sperm in the body wall. An egg unites with a sperm, grows larger, and eventually separates from the parent and drops into the water. A tough outer capsule protects the egg from damage, freezing, or drying out. After a while, a small hydra hatches.

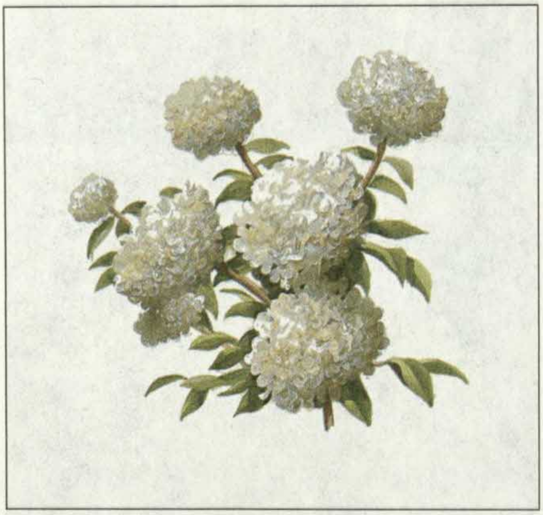
Hydras can *regenerate* (regrow) parts of their bodies. It is estimated that in a period of several weeks a hydra replaces all the cells in its body. The hydra, therefore, never grows old.

Scientific classification. Hydras belong to the phylum Cnidaria and the class Hydrozoa.

Hydra was a many-headed serpent of Greek mythology. It is known as the *Lernaean Hydra* or the *Hydra of Lerna* because it lived in Lake Lerna in Argolis. One of the hydra's heads could not die, and the rest grew back as soon as they were cut off. However, Hercules and his nephew Iolaus killed the monster by first cutting off all the heads except the immortal one and sealing each neck with fire. Hercules then cut off the immortal head and buried it under a rock. See also **Hercules** (The twelve labours).

Hydrangea is the name of about 80 species of handsome shrubs and climbers. Hydrangeas are native to North and South America, China, and Japan. They are widely cultivated as garden plants. They may be *deciduous,* which means they lose their leaves each autumn, or evergreen.

Hydrangeas bear white, pink, or bluish flowers. Each



Hydrangeas include many species of attractive flowering shrubs. The small flowers are arranged in large, often rounded flowerheads. Some hydrangeas are climbing plants.

small flower grows with many others in large, showy clusters. Hydrangeas need rich and slightly moist soil. They grow well in partly shaded places. They flower more freely in the sun if they have sufficient moisture. Hydrangeas are grown from cuttings or seeds. They bloom from late summer until autumn.

Scientific classification. Hydrangeas belong to the saxifrage family, Saxifragaceae.

See also **Flower** (picture: Garden perennials [Flowering shrubs]).

Hydrate is a chemical compound made of a definite amount of water and another substance. For example, the hydrate *blue vitriol* (copper sulphate pentahydrate) is formed by the combination of a copper atom, a sulphur atom, and four oxygen atoms with five water molecules. Its chemical formula is $CuSO_4 \cdot 5H_2O$. When the water in a solution of copper sulphate evaporates, the blue vitriol crystals that form are dry. But they retain a certain amount of water. This water is called *water of crystallization* or *water of hydration.*

In many cases, the water of hydration is driven off by heating the hydrate. The compound then becomes *dehydrated.* When all the water is gone, the compound becomes *anhydrous.* Anhydrous salts often differ from their hydrates in colour and crystal form. The blue crystals of blue vitriol change into a white powder when the compound becomes anhydrous. Anhydrous copper sulphate has the formula $CuSO_4$.

Some hydrates, such as *washing soda* (sodium carbonate decahydrate, $Na_2CO_3 \cdot 10H_2O$), spontaneously lose their water of hydration when exposed to the air at room temperature. These compounds are called *efflorescent.* Their crystals slowly turn into a powder as they lose water. Efflorescence takes place faster when the humidity is low (when there is little moisture in the atmosphere).

Hydraulic brake. See Brake.

Hydraulic engine, or *fluidic engine,* is a machine that produces motion by means of pressure from water or some other fluid. This type of engine can be used to drive machinery or move heavy loads. Examples of hydraulic engines include jacks, hoists, the power steering and brake mechanisms of cars, and the control systems of aircraft.

There are two basic types of hydraulic engines—*reciprocating engines,* such as hydraulic lifts and suction pumps; and *turbines,* such as those that turn electric generators. Reciprocating engines operate at slow speeds. Turbines usually function at higher speeds.

Early hydraulic engines used water to produce power. Today, engines that use water are rare except for water turbines in hydroelectric plants. Modern hydraulic engines use fluids that do not freeze at low temperatures. Such fluids include oil, certain silicones, and some gases. The fluid in some hydraulic engines is put under pressure mechanically. In other engines, the pressure comes from the weight of the fluid stored in a reservoir above the engine.

See also **Hydraulics; Locomotive** (Diesel locomotives); **Pump** (Reciprocating pumps); **Turbine** (Water turbines).

Hydraulics is the branch of physics that studies the behaviour of liquids at rest and in motion. Some laws of hydraulics apply to both gases and liquids. But they apply only under certain conditions, such as when gases flow at low velocity and are not compressed. Scientists sometimes divide the study of hydraulics into two categories—*hydrostatics* and *hydrodynamics.* Hydrostatics describes the behaviour of liquids at rest. Hydrodynamics is concerned with the behaviour of liquids in motion.

Hydraulics is studied and applied in two of the speciality fields of engineering: civil engineering and mechanical engineering. Civil engineers use the principles of hydraulics mainly to study the flow of water in open or partially filled pipes. They design embankments and levees that provide flood control along rivers, as well as canals, irrigation systems, and sewage systems. They also plan water supply systems for cities and towns.

Mechanical engineers are usually more concerned with the flow of fluids in filled pipes under pressure. They use the principles of hydraulics to design *hydraulic machines.* These machines include hydraulic turbines, hydraulic brakes, power steering for cars, controls for aeroplanes and spacecraft, and construction equipment.

Pressure from water or some other fluid supplies the power that runs hydraulic machines. Some hydraulic machines, including turbines, operate by the force of a flowing fluid. Turbines are large wheels that change the potential energy of a fluid into work that can be used to power an electric generator or perform some other type of work. Steam or gas powers other kinds of turbines.

Other hydraulic machines, called *hydraulic presses,* increase and transfer force through a fluid from one piston to a larger piston. Industry uses hydraulic presses for such jobs as lifting heavy loads and pressing metal parts. One form of hydraulic press is called a *hydraulic jack.*

Liquids at rest

Use of hydrostatic principles is fundamental to the design of many machines and instruments. The design of hydraulic presses and the operation of such instruments as manometers and barometers depend on laws of hydrostatics.

A simple hydraulic press consists of a cylinder that contains two pistons, one smaller than the other. The cylinder is filled with a fluid. A force applied to the smaller piston is transferred through the fluid to the larger piston. The force increases in direct proportion to the ratio of the area of the larger piston to the area of the smaller piston. Car brakes operate on the principle of the hydraulic press. Pressure applied to the brake pedal is transmitted through a liquid to brake shoes, which press against the car's wheels.

A *manometer* measures the pressure exerted by a liquid or a gas. The simplest kind of manometer is a U-shaped tube with open ends. The tube contains a liquid, usually mercury or water, which fills the bottom of the U and rises a short distance in each arm. The liquid in the manometer must have a different weight per unit of volume than the substance whose pressure is to be measured. One arm is connected to the place where the pressure is to be measured. The other arm remains open to the atmosphere. The difference in liquid level in the arms indicates the pressure compared to atmospheric pressure. See **Manometer.**

A *barometer* measures atmospheric pressure. It is used primarily to forecast weather and to measure heights of mountains. One type of barometer consists basically of a tube containing mercury. At sea level, a column of mercury about 75 centimetres high equals in weight the force of atmospheric pressure on that column. The level of mercury in the tube rises or falls as the atmospheric pressure changes. See **Barometer.**

Laws of hydrostatics describe the behaviour of liquids at rest.

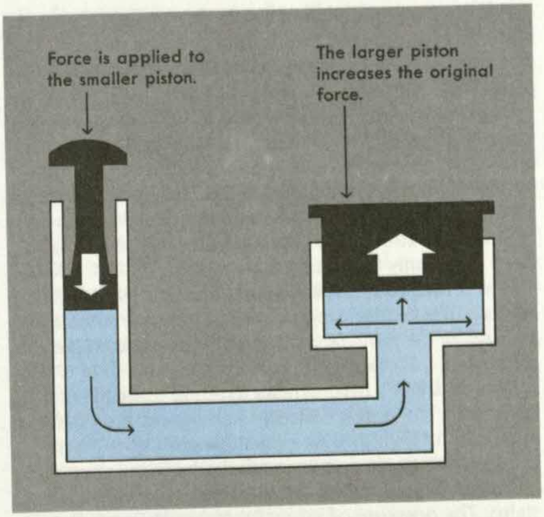
One principle of hydrostatics states: *The pressure caused by the weight of a column of fluid is determined by the height of the column.* The shape of the column does not affect the pressure that is exerted by the fluid.

Suppose that a pipe extends in a zigzag pattern from the ceiling to the floor. Another pipe of equal diameter extends straight down from the ceiling to the floor. The second pipe is, of course, shorter than the first. If both pipes are filled with water, the longer one will hold more water. But the water pressure at the bottom of both pipes will be equal because the height of both columns of water is equal.

An illustration of the above principle is the buoyant force exerted by a fluid on an object submerged in it. The bottom of an object submerged in water is deeper than the top of the object. Therefore, the column of water pressing on the bottom of the object is taller than the column pressing on the top of the object. Thus, the water exerts an upward force on the object, called a *buoyant force.* Buoyant forces act to keep boats afloat.

Archimedes' principle comes from the principle discussed above. It states: *An object placed in a fluid seems to lose an amount of weight equal to the weight of the fluid it displaces.* A buoyant force exerted on the object by the fluid causes the apparent loss of weight. Archimedes, a Greek mathematician, developed this principle during the 200's B.C.

To illustrate this principle, imagine that a 1-litre metal can is placed in water. If the can weighs 3 kilograms, it will displace 1 litre of water, which weighs 1 kilogram. Thus, the buoyant force equals 1 kilogram. The can will then seem to weigh only 2 kilograms—that is, 1 kilogram less than its original weight.


Force is applied to the smaller piston.
The larger piston increases the original force.

A hydraulic press increases and transfers the force applied to one piston through a liquid to a larger piston. The force increases in direct proportion to the ratio of the area of the larger piston to the area of the smaller piston. Industry uses hydraulic presses to lift heavy loads.

Pascal's law states: *A fluid in a container transmits pressure equally in all directions.* Blaise Pascal, a French scientist and mathematician, developed this law during the A.D. 1600's.

To illustrate Pascal's law, take a bottle with a neck opening of 10 square centimetres and fill it with water. Put a plug in the neck so that the plug seals the top of the bottle and moves freely in the neck. Place a 1 kilogram weight on the plug. The pressure of the water will increase by 1 kilogram over each square centimetre of the inside surface of the bottle.

Liquids in motion

Use of hydrodynamic principles is basic to hydraulic engineering and to the design of certain machines. Engineers use hydrodynamics when planning water supply systems, canals, and irrigation systems. They also apply hydrodynamic principles to the design of aeroplanes and to the construction of certain hydraulic machines, such as water turbines.

Engineers consider many factors to determine the proper pressure for a water supply system. For instance, the height of the reservoir or tank affects the pressure in water flow from the reservoir, and this pressure determines the flow rates that can be obtained. Most reservoirs have a long series of pipes that connects the source of water with its destination. Such factors as pipe size and the friction between the water and the pipes affect the flow of water.

Laws of hydrodynamics play a fundamental role in the design of water turbines. Some water turbines are submerged in rivers, and the normal flow of water provides power. Other water turbines are located at the bases of dams. Water pressure created by the dam is used to speed up the water when it enters the turbine. The turbines then change the kinetic energy of the moving water into rotational energy, which turns generators that produce electricity.

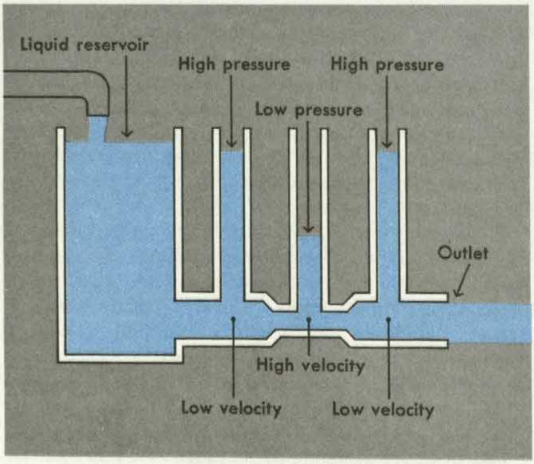
Laws of hydrodynamics describe the behaviour of flowing fluids. Fluid flow may be steady or unsteady. An unsteady flow results from changes in the velocity, temperature, or pressure of a fluid. The movement of a fluid around obstructions may also cause an unsteady flow.

There are three basic laws of hydrodynamics. All of them apply only to steadily flowing liquids.

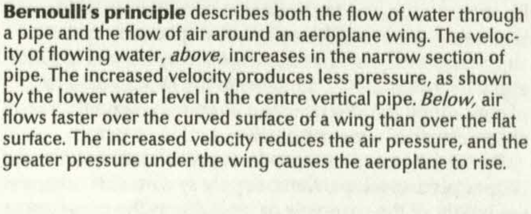
The principle of continuity in fluid flow states: *The velocity of a fluid flowing through a pipe increases as the area of the pipe decreases, and decreases as the pipe's area increases.*

The nozzle of a garden hose uses the principle of continuity. The nozzle decreases the size of the opening at the end of the hose. As a result, water flows faster through the nozzle than through the hose.

Bernoulli's principle, also called *Bernoulli's law,* states: *The pressure of a fluid increases as its velocity decreases, and decreases as the fluid's velocity increases.* Daniel Bernoulli, a Swiss mathematician, developed this principle during the 1700's.



Bernoulli's principle describes both the flow of water through a pipe and the flow of air around an aeroplane wing. The velocity of flowing water, *above,* increases in the narrow section of pipe. The increased velocity produces less pressure, as shown by the lower water level in the centre vertical pipe. *Below,* air flows faster over the curved surface of a wing than over the flat surface. The increased velocity reduces the air pressure, and the greater pressure under the wing causes the aeroplane to rise.


Higher velocity, less pressure
Motion of wing
Air flow
Wing
Lower velocity, greater pressure

Bernoulli's principle is used in the design of aeroplane wings. Engineers curve the upper surface of the wing so air will flow faster over the top than it does over the bottom of the wing. The faster-flowing air exerts less pressure on the top of the wing. As a result, the greater pressure under the wing lifts the aeroplane.

Torricelli's law states: *The velocity with which a liquid flows through an opening in a container equals the velocity of a body falling from the surface of the liquid to the opening.* Evangelista Torricelli, an Italian physicist, developed this law during the 1600's.

According to Torricelli's law, a stream of water flowing through a hole 3 metres below the water surface in a dam has the same velocity as a stone falling that 3-metre distance. Torricelli's law does not apply to gases because a gas has no surface. The velocity at which a gas flows from a container depends on the pressure under which the gas is confined in the container.

Related articles in ***World Book*** include:

Archimedes
Bernoulli's principle
Brake
Hydraulic engine
Pascal, Blaise
Pump
Turbine
Water power

Hydraulus. See **Organ** (History).

Hydrazine is an important chemical compound used in jet and rocket fuels. Industry also uses it to make agricultural and textile chemicals, explosives, photographic developers, and blowing agents used in the manufacture of foam rubber. Hydrazine derivatives are used to regulate the growth of plants, such as grass alongside motorways. These chemicals keep the grass from growing so fast that it needs constant attention.

Hydrazine occurs as a colourless, fuming, corrosive liquid. This is a nitrogen-containing base and a powerful reducing agent (see **Base**). It mixes readily with water and alcohol. Hydrazine boils at 114° C and its chemical formula is H_2NNH_2. It burns readily in air, giving off a great amount of heat, to form nitrogen gas and water. Industry prepares it by various methods from hydrazine hydrate, $H_2NNH_2{\cdot}H_2O$.

Hydriodic acid. See **Hydrogen iodide.**

Hydrobromic acid. See **Hydrogen bromide.**

Hydrocarbon refers to the most important class of organic compounds. Hydrocarbons contain only the elements hydrogen and carbon. They occur in petroleum and natural gas. Commercial petroleum products such as petrol, paraffin, aeroplane fuel, lubricating oils, and paraffin wax, are mixtures of hydrocarbons. Some hydrocarbons are found in coal tar and coal gas. Many others are *synthesized* (made artificially) from hydrocarbons found in nature.

Hydrocarbons are starting materials for the petrochemical industry. Petrochemical companies use hydrocarbons from crude oil and natural gas to manufacture solvents, plastics, and synthetic fibres and rubbers.

Organic chemistry is sometimes called the "chemistry of hydrocarbons and their derivatives," because all organic compounds are essentially related to the hydrocarbons. Hydrocarbons can be divided into three large classes: (1) aliphatics, (2) alicyclics, and (3) aromatics.

Aliphatic hydrocarbons have the principal carbon atoms arranged in chains. They are further divided into the paraffin, olefin, and acetylenic series.

Paraffins or ***alkanes*** include the greatest number of hydrocarbon compounds. They have the general formula C_nH_{2n+2}. Methane, CH_4, is the first member of the series. Others are formed by adding CH_2 groups to methane. For example, ethane is C_2H_6, and propane is C_3H_8. Paraffins react by *substitution.* Hydrogen atoms are replaced by other atoms or groups of atoms, such as halogens or hydroxyls.

Olefins or *alkenes* have at least one double bond between two carbon atoms. They have the general formula C_nH_{2n}. Ethylene, C_2H_4, is the first member. Olefins react primarily by *addition* of molecules such as water, oxygen, and halogens. They can also react with themselves to form *polymers* (large chain molecules) such as polyethylene, which is used in plastics.

Acetylenes or *alkynes* have at least one triple bond between two carbon atoms. They have the general formula C_nH_{2n-2}. Acetylene, C_2H_2, is the first and most important member of the series. Acetylenic hydrocarbons have reactions similar to the olefins.

Alicyclics have their carbon atoms arranged in a ring. These atoms may have single or double bonds between them. Triple bonds in alicyclics are rare, but they can occur in sufficiently large rings. Many important naturally occurring organic compounds fall into this class. The reactions of alicyclics are similar to those of the aliphatics.

Aromatics are a small but highly important class of hydrocarbons. They are characterized by a six-carbon ring. This ring differs from the alicyclics in that it contains three double bonds. *Benzene,* C_6H_6, is the most important aromatic. Others in the benzene series include toluene, $C_6H_5CH_3$, and the xylenes, $C_6H_4(CH_3)_2$. Other aromatic series include the *naphthalenes,* $C_{10}H_8$, and the *anthracenes,* $C_{14}H_{10}$.

Related articles in ***World Book*** include:

Acetylene
Benzene
Carbon
Coal tar
Coke oven gas
Damp
Ethane
Ethylene
Methane
Natural gas liquids
Paraffin
Petroleum
Smog (Photochemical smog)
Toluene

Hydrochloric acid is a dangerous chemical that has many important industrial uses. The acid is a colourless liquid with an irritating odour. It fumes when exposed to air. It is highly corrosive and can cause serious burns.

Hydrochloric acid is also called *muriatic acid.* Its chemical formula is HCl. The acid is made by dissolving hydrogen chloride gas in water. The hydrogen chloride gas itself is prepared by burning hydrogen and chlorine gases together or by treating common table salt, sodium chloride, with sulphuric acid. Hydrochloric acid is most commonly sold as a 30 per cent solution, called concentrated hydrochloric acid. Neutralization of the acid forms salts called *chlorides.*

Industry uses hydrochloric acid in preparing many chemical compounds. The acid is also used in metallurgy and food processing. The human stomach secretes small amounts of hydrochloric acid, which aids in digestion. However, excess production of the acid by the stomach contributes to the formation of stomach ulcers.

See also **Acid; Aqua regia; Chloride.**

Hydrocyanic acid gas. See **Gas chamber; Prussic acid.**

Hydrodynamics. See **Hydraulics.**

Hydroelectric power. See **Electric power; Water power.**

Hydrofluoric acid is an *extremely* dangerous inorganic chemical. It is produced by dissolving hydrofluoric gas in water. The chemical formula of hydrofluoric acid is HF. Neutralization of the acid forms salts called *fluorides.*

Hydrofluoric acid is used in manufacturing aluminium and certain refrigerants. Industry also uses it to etch glass. In the laboratory, hydrofluoric acid is used in separating uranium isotopes (see **Uranium**).

Hydrofluoric acid is a colourless liquid with an irritating odour. The acid fumes when exposed to air. It is highly corrosive and can cause serious and painful burns to the skin, eyes, and mucous membranes. Burns from dilute hydrofluoric acid may not be immediately evident, but may appear later as deep ulcerations.

Because hydrofluoric acid corrodes glass, ceramic, and many metals, containers made from these materials are unsuitable for storing it. Instead, the acid is usually stored in polyethylene containers.

Hydrofoil is a boat whose hull can lift above the surface of the water when travelling at high speeds. The craft has wings that are designed to move underwater. These wings, which are called *foils,* have a curved upper surface and work like aeroplane wings to lift the hull above the water.

The foils are attached to the hull of the boat by long, thin supports called *struts.* At low speeds, the hydrofoil moves through the water on its hull. When the craft reaches higher speeds, water rushes over the foils at a fast rate. This water action decreases the pressure on the top of the foils and causes them to rise in the water. The hull of the hydrofoil then "flies" above the water on its foils. The lift of the foils supports the hull on its struts.

Hydrofoils use less engine power than other kinds of vessels when travelling at high speeds, because their hulls do not have to be pushed through the water. They generally travel at speeds from 30 to 55 knots. One knot equals 1.85 kilometres per hour. Experimental craft have reached speeds of more than 80 knots.

An important feature of hydrofoils is their ability to ride smoothly in rough water at high speeds. The foils act to reduce the effects of waves on the craft, both when it is *foilborne* (travelling on its foils) and when it is *hullborne* (travelling on its hull).

Commercial hydrofoils carry hundreds of thousands of passengers and many tons of supplies and equipment each year. Passenger hydrofoils operate between the islands of Greece, across the English Channel, and in many other parts of the world. Russia operates a large fleet of commercial hydrofoils.

Military hydrofoils perform such duties as carrying out patrol missions and tracking enemy vessels at high speeds. Some carry guided missiles. Before its breakup, the Soviet Union had more military hydrofoils than any other country. Other countries that operate military hydrofoils include Italy, the United Kingdom, and the United States.

Kinds of hydrofoils

Hydrofoils range from about 5 to 60 metres in length. Most are powered by gas turbine or diesel engines, or both. Propellers or waterjets propel the craft.

Commercial hydrofoils typically serve as passenger ferries between islands, along seacoasts, and on rivers. The commercial hydrofoil shown on the left operates on a waterway in Hong Kong.

When a hydrofoil is foilborne, its weight is generally distributed between two foils, one at the bow and one at the stern. In the *canard system,* the foil at the stern is larger than the one at the bow. In the *tandem system,* both of the foils are of equal size. The *aeroplane system* has a larger foil at the bow than it has at the stern.

In rough water, hydrofoils change their "flight" path to keep their hulls above the waves. When the waves are small in comparison to the hydrofoil, the craft easily clears the tops of the waves while maintaining a fixed path. This method is called *platforming.* When the waves are large in comparison to the hydrofoil, the craft adjusts its path to follow the shape of the waves. This method is called *contouring. Intermediate response* combines features from both platforming and contouring for travelling over small and large waves. The hydrofoil maintains a fixed path when moving over the small waves, but it follows the shape of the waves when travelling over large ones.

Hydrofoils are classified according to the way their foil systems operate when they are foilborne. There are two basic types: (1) surface-piercing hydrofoils and (2) fully submerged hydrofoils.

Surface-piercing hydrofoils are most commonly used on rivers, lakes, and other areas where the water is relatively calm. Two popular types of surface-piercing craft are the *V-foil hydrofoil* and the *trapeze-foil hydrofoil.* The V-foil hydrofoil has foils that form a "V" shape. The trapeze-foil hydrofoil has foils that form part of a trapezoid.

Surface-piercing hydrofoils use the surface area of the foils for stability and control. When a surface-piercing hydrofoil is in "flight," the upper parts of the foils stick out of the water. The speed of the craft determines the distance of the hull above the water. As the speed of the craft increases, the foil area required for lift decreases, and the upper part of the foil therefore rises out of the water. When the speed decreases more area is required to lift the craft, and the foils settle deeper into the water.

Fully submerged hydrofoils are used most often in oceans or other areas where exceptionally rough water might be encountered. The foils of a fully submerged hydrofoil stay completely underwater when the craft is in "flight." The craft is kept stable by changing the angle of the foils, called their *angle of attack,* to keep water flowing over them at an even rate. The angle of attack of fully submerged hydrofoils is changed through the use of automatic stabilizing systems. These systems are either electrical or mechanical.

Electrical stabilizing systems use *sensors* (detecting devices) to pick up changes in the size of the waves. The

Military hydrofoils, such as the United States Patrol Hydrofoil Missileship (PHM) shown on the left, are used primarily to patrol coastal waters and to track enemy vessels. PHM's carry guided missiles.

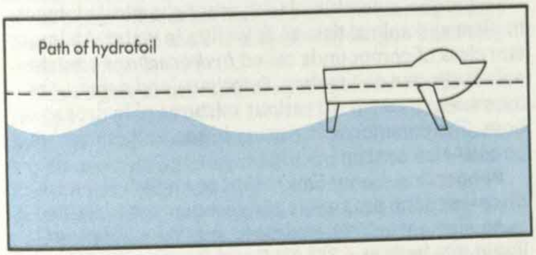
sensors feed this information into a computer, which sends signals to the craft's stabilizing equipment to adjust the angle of attack. Some craft make such adjustments through the use of movable flaps on the foils. Others have air pumps that create an air cavity around the foils.

Mechanical stabilizing systems use floats attached to the foils by mechanical links to change the angle of attack. The floats ride along the surface of the water. As they travel up and down the waves, they move the mechanical links. This action then rotates the foils.

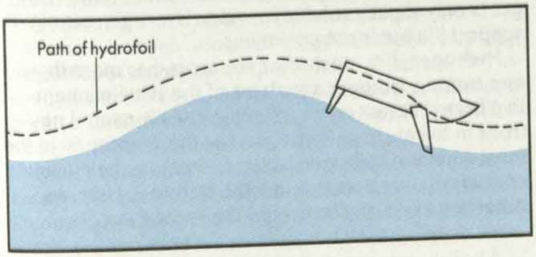
Fully submerged hydrofoils called *shallow draught hydrofoils* have the self-stabilizing ability of surface-piercing hydrofoils. The foils of these craft lose lift as they approach the water surface and do not rise higher than one *chord* (the distance from the front edge to the back edge of the foil) from the surface. They maintain this height as long as their speed is kept constant. These craft are used on calm, shallow waterways.

How hydrofoils travel over waves

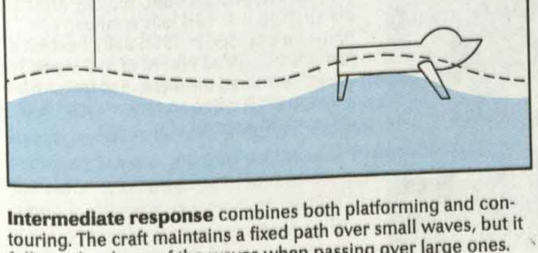
Hydrofoils travelling in rough water keep their hulls above the waves in three basic ways. These methods are (1) platforming, (2) contouring, and (3) intermediate response.



Platforming occurs when the waves a hydrofoil encounters are small in comparison to the size of the craft. The craft maintains a fixed path and the hull easily passes above the water.

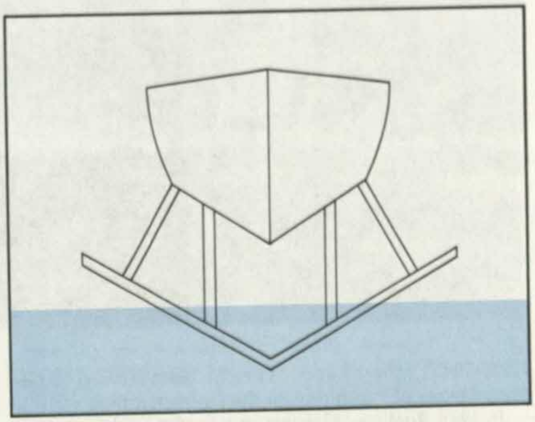


Contouring is used when the waves are large in comparison to the size of the hydrofoil. The craft adjusts its path to match the shape of the waves, and it rides up and down them.

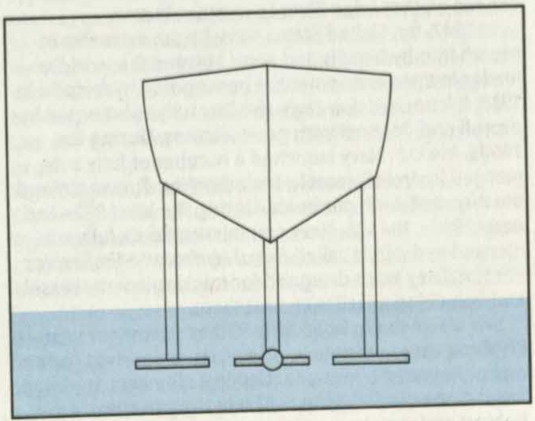


Intermediate response combines both platforming and contouring. The craft maintains a fixed path over small waves, but it follows the shape of the waves when passing over large ones.

Two kinds of hydrofoils



Surface-piercing hydrofoils ride on foils that are only partly submerged. The upper part of the foils rides above the surface of the water and helps to stabilize the craft.



Fully submerged hydrofoils travel with their foils completely underwater. Fully submerged hydrofoils perform well in rough water but need special stabilizing equipment to ride smoothly.

History

Early hydrofoil experiments began in Europe during the late 1800's. In 1906, an Italian engineer named Enrico Forlanini successfully tested the first full-sized, self-propelled hydrofoil. In 1907, the Scottish-born inventor Alexander Graham Bell started work on a series of hydrofoils he called *Hydro-Dromes.* In 1918, one of these craft, the *HD-4,* set a world water speed record of 61.6 knots. This record remained the top speed for a hydrofoil until 1963, when an experimental hydrofoil developed in the United States, the *Fresh I,* set the new record of 84 knots.

Modern hydrofoil development. In 1927, Baron Hanns von Schertel, a German engineer, started work on designing a hydrofoil for commercial use. After nine years of trials, Schertel developed a surface-piercing V-foil that eventually became the first passenger hydrofoil to be put into regular service. During World War II

Shallow draught hydrofoils are a common means of water transportation in Russia. Scientists in Russia developed the shallow draught hydrofoil during the 1940's, and such craft began regular commercial service in Russia in 1957.

(1939-1945), Schertel and his design team created 15 different types of hydrofoils for the German military.

In 1945, Rostislav Alekseev, a scientist working in Russia, began experiments that led to the development of the shallow draught hydrofoil. In 1957, Alekseev's first shallow draught vessel, the *Raketa,* began passenger service on the Volga River in western Russia.

In 1947, the United States Navy began extensive research into hydrofoils and soon became the world's leader in the development of oceangoing hydrofoils. In 1958, it launched *Sea Legs,* the first fully submerged hydrofoil craft to meet with great success. During the 1960's, the U.S. Navy launched a number of fully submerged hydrofoil vessels, including the *Tucumcari* and the *Flagstaff,* both gunboats. During the late 1970's and early 1980's, the U.S. Navy commissioned six fully submerged hydrofoils called *Patrol Hydrofoil Missileships* (*PHMs*). They were designed for tracking enemy vessels and launching missiles against them.

See also **Missile boat; Ship** (Other passenger vessels).

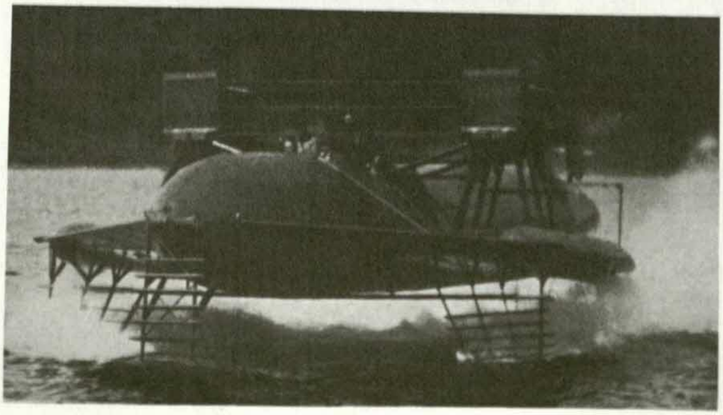
Hydrogen is a tasteless, odourless, colourless gas and one of the most important chemical elements. Hydrogen has the chemical symbol H. The hydrogen atom is the lightest and simplest atom known. This atom consists of only one proton, which has a positive charge, and one electron, which has a negative charge. Its atomic number is 1, and its atomic weight is 1.0079. The term *hydrogen* comes from two Greek words meaning *water-former.* A water molecule consists of two hydrogen atoms and one oxygen atom.

Occurrence. Hydrogen is the ninth most abundant element in the earth's crust. It makes up almost 1 per cent of the crust. Most of this hydrogen occurs in combination with other elements. However, pockets of uncombined hydrogen have caused violent explosions in underground coal mines. The sun and many other stars consist mostly of hydrogen.

Hydrogen is combined with other chemical elements in plant and animal tissues as well as in water. An important class of compounds called *hydrocarbons* contain only hydrogen and carbon. Petroleum and natural gas, for example, consist of various mixtures of hydrocarbons. The common acids, many bases, and other compounds also contain hydrogen.

Properties. Henry Cavendish, an English scientist, discovered the properties of hydrogen and identified it as an element in 1766. Hydrogen may be condensed to a liquid that boils at −257.87° C and freezes at −259.14° C. The gas is so light that it weighs about one-fourteenth as much as an equal volume of air. At 20° C, hydrogen has a density of 0.00008375 gram per cubic centimetre. The gas is only slightly soluble in water. Hydrogen cannot support life but is not poisonous.

Hydrogen, like most other elements, has more than one *isotope.* Isotopes are atoms of the same element that have different numbers of electrically neutral neutrons in the nucleus. Hydrogen has three isotopes. In the most common hydrogen isotope, *protium,* the nucleus consists of only a proton. In 1932, Harold C. Urey, an American chemist, discovered the second isotope,



An early hydrofoil boat, built by Alexander Graham Bell, had foils arranged like rungs on a ladder. In 1918, Bell's boat set a world water speed record of 61.6 knots. This record remained the top speed for a hydrofoil until 1963, when an experimental hydrofoil reached a speed of 84 knots.

called *deuterium* or *heavy hydrogen.* For this discovery, Urey won the 1934 Nobel Prize for chemistry. The nucleus of a deuterium atom has one proton and one neutron. Deuterium atoms make up about 1 part in 4,000 to 6,000 parts of normal hydrogen. In 1934, scientists discovered the third isotope, *tritium.* Its nucleus has one proton and two neutrons. It is radioactive and has been used in the hydrogen bomb. See **Deuterium; Tritium.**

Preparation of hydrogen. In the laboratory, hydrogen can be produced by the electrolysis of water (see **Electrolysis**). In electrolysis, an electric current breaks down the water into its two elements, the gases hydrogen and oxygen. Commercially, large amounts of hydrogen are a by-product of the manufacture of sodium hydroxide by the electrolysis of brine. But most commercial hydrogen is produced either by passing steam over hot coke or iron or by causing steam and natural gas to react in the presence of a catalyst (see **Catalysis**).

Sodium and many other active metals react directly with water and release hydrogen from the water even at room temperature. Less chemically active metals, such as magnesium, will liberate hydrogen from steam (see **Electromotive series**). Zinc and numerous other metals react better with acids than with water. Sometimes, these metals are used to displace hydrogen from solutions of acids in water.

Hydrogen compounds. Hydrogen combines directly with several of the most active elements, but most hydrogen compounds are made by indirect methods. When two hydrogen atoms unite and form a molecule, they give off relatively large amounts of heat. Hydrogen's ability to ignite makes it useful in producing a number of compounds. For example, mixtures of hydrogen and oxygen explode violently when ignited by a spark. In the presence of air or oxygen, hydrogen burns with a hot flame and forms water. Chlorine burns in hydrogen and forms a colourless gas, *hydrogen chloride* (HCl). Solutions of hydrogen chloride in water are known as *hydrochloric acid.* In the Haber process, large quantities of *ammonia* (NH_3) are made by combining hydrogen and nitrogen. Other hydrogen compounds prepared indirectly include *hydrogen peroxide* (H_2O_2), *acetic acid* (CH_3COOH), and *ethyl alcohol* (C_2H_5OH).

Under suitable conditions, hydrogen combines directly with a variety of compounds. In the Patart process, it combines with carbon monoxide (CO) and forms *methanol,* or wood alcohol (CH_3OH). It also unites with liquid fats and forms solid fats. This process, called *hydrogenation,* is used to convert vegetable oils into semisolid shortenings used in cooking (see **Hydrogenation**).

Uses. Many hydrogen compounds, such as ammonia, ethyl alcohol, and hydrogen peroxide, have extensive industrial uses. Hydrogen is widely used to recover some metals from their compounds because it is a good *reducing agent.* In other words, hydrogen can withdraw oxygen and other nonmetallic elements from metallic compounds, leaving a pure metal. For example, pure metallic tungsten can be formed by passing a stream of hydrogen over heated tungsten trioxide. The hydrogen removes the oxygen and unites with it, forming water. In the same way, free metal and hydrogen chloride result when hydrogen passes over certain hot metallic chlorides. Water and iron result when iron rust, or ferric oxide, is heated with hydrogen. Hydrogen's low density also makes it useful for inflating balloons.

Hydrogen's ability to produce heat when united with oxygen makes it a good fuel. Scientists in such countries as Canada, Japan, the United States, and the Soviet Union have developed or are researching ways to use hydrogen as an energy source. For example, hydrogen fuel powers the main engine of the orbiter in the United States space shuttle system. In New York City, a power plant uses hydrogen fuel to produce electricity. Engineers have built experimental cars that run on hydrogen fuel. By chemically adding hydrogen to coal, coal can be converted into petrol, fuel oil, or synthetic natural gas (see **Coal** [The coal industry]).

Related articles in *World Book* include:

Ammonia
Atom (diagrams: How atoms compare; The isotopes of hydrogen)
Cavendish, Henry
Gas
Heavy water
Hydrocarbon
Hydrochloric acid
Hydrogen bromide
Hydrogen iodide
Hydrogen peroxide
Nuclear weapon

Hydrogen bomb. See **Nuclear weapon; Fallout.**

Hydrogen bromide (chemical formula, HBr) is a colourless gas that fumes in moist air. It can be prepared by combining hydrogen (H) and bromine (Br) directly, or by treating a salt of HBr, such as sodium bromide ($NaBr$), with a strong nonvolatile acid. A solution of hydrogen bromide in water is called *hydrobromic acid.* Both HBr gas and the water solution are used in making various organic compounds.

Hydrogen chloride. See **Hydrochloric acid.**

Hydrogen fluoride. See **Hydrofluoric acid.**

Hydrogen iodide (chemical formula, HI) is a heavy, colourless gas with a strong odour. Chemists prepare it by combining hydrogen and iodine at 200° to 300° C, or by adding water to a mixture of iodine and red phosphorus.

Hydrogen iodide dissolves readily in water to form hydriodic acid, also called hydroiodic acid, a *strong* (extremely active) acid. Chemists use hydriodic acid in laboratory experiments as a powerful *reducing agent.* Such a substance gives some of its electrons to other substances during a chemical reaction. The acid is too expensive for large-scale industrial use.

Hydrogen peroxide is an important industrial chemical that consists of hydrogen and oxygen. Its chemical formula is H_2O_2.

Hydrogen peroxide, also called *hydrogen dioxide,* is a colourless, syrupy liquid that has a sharp odour. Chemists classify any solution of water and hydrogen peroxide that contains more than 8 per cent hydrogen peroxide as corrosive. Such solutions irritate the skin, eyes, and mucous membranes. Concentrations of hydrogen peroxide higher than 50 per cent can cause serious burns.

Pure hydrogen peroxide is stable if handled properly and kept free from contamination. Such factors as light, heat, chemical catalysts, dirt, and rust may cause hydrogen peroxide to decompose into water, oxygen, and heat. Decomposition of a sufficiently concentrated hydrogen peroxide solution yields enough heat for an explosion. Contact with combustible materials may result in fire. However, hydrogen peroxide's instability makes it a good oxidizing agent because the oxygen freed in decomposition readily combines with other substances.

Hydrogen peroxide is widely used in industry. Solutions containing 3 to 6 per cent hydrogen peroxide are used as antiseptics and germicides and as a skin cleanser. Higher concentrations are used in the manufacture of many chemical compounds. They also serve as bleaching agents for textiles and paper pulp, and as rocket propellants.

See also **Antiseptic; Barium; Bleach; Oxidation.**

Hydrogen sulphide is a colourless, extremely poisonous gas that smells like rotten eggs. Its chemical formula is H_2S. Eggs and many other substances contain organic compounds made up partly of sulphur. When such compounds decompose, they produce hydrogen sulphide. For this reason, the gas may be present in the air around cesspools and sewers. The decomposition of metal sulphides also produces hydrogen sulphide, resulting in the presence of the gas in mines and mineral springs.

Hydrogen sulphide is flammable. It dissolves slightly in water, forming a weak acid called *hydrosulphuric acid.* Small amounts of hydrogen sulphide in the air cause silver objects to tarnish. Chemists usually make hydrogen sulphide in the laboratory by combining hydrochloric acid and iron sulphide. They use the gas mainly in analysing the composition of other substances. Hydrogen sulphide is also used in the production of high-pressure lubricants and oils.

Hydrogenation is a chemical process that adds hydrogen to a substance. Oils and liquid fats are often hydrogenated to improve their quality. For example, peanut oil is hydrogenated to change it to a solid and improve its odour and flavour. The hydrogenation process is important in the preparation of petrols. Hydrogen is added to the ends of long petroleum molecules after they are cracked by heat and pressure to form shorter molecules of petrol. Hydrogenation is used in making crude oil from coal. In this process, powdered coal is mixed with a little oil and hydrogenated under heat and pressure.

A substance whose molecules contain some hydrogen atoms, but can accept more, is said to be *unsaturated.* For example, the gas *ethylene* (C_2H_4) is an unsaturated compound. When ethylene is hydrogenated, the double *bond* (chemical connection) that links its two carbon atoms breaks. This leaves a single bond and adds two hydrogen atoms to the molecule. The resulting compound is a gas called *ethane* (C_2H_6). Ethane is called a *saturated* compound because its molecules contain as many hydrogen atoms as they can.

Catalysts (substances that speed up chemical reactions) are needed to make hydrogenation economical. In 1912, French chemist Paul Sabatier received the Nobel Prize for chemistry for discovering that nickel is a good hydrogenation catalyst. Other catalysts used today for hydrogenation include platinum and *Raney nickel* (an aluminium-nickel alloy treated with caustic soda).

See also **Coal** (Coal research).

Hydrography is the branch of physical geography that deals with the surface waters of the earth. Most countries of the world have developed well-organized hydrographic agencies. Hydrographers make studies of navigable water, including oceans, rivers, and lakes. They make and publish charts and maps which show the formation of the coasts, the depth of the waters, and the position of channels, reefs, shoals, rocks, and currents. Hydrographers also study tides and winds.

Hydrolite. See **Geode.**

Hydrologic cycle. See **Water** (Nature's water cycle).

Hydrology is the study of the movement and distribution of the waters of the earth. People use billions of litres of fresh water every day. *Hydrologists* (scientists who study water) help provide information needed to find adequate supplies of fresh water. They also study floods and water pollution. In addition, hydrologists study the chemical and physical properties of water.

In nature, water circulates through a system called the *water cycle* or *hydrologic cycle.* This cycle begins when heat from the sun causes ocean water to evaporate and become water vapour. The atmosphere holds the water vapour while the vapour gradually cools and forms clouds. The water eventually falls as rain or snow. Most rain and snow falls back into the oceans. But some falls on the land and flows back to the seas, completing the cycle. See **Water** (Nature's water cycle).

There are two main sources of fresh water: (1) surface water and (2) ground water. Surface water flows over the land in lakes, rivers, and streams. Ground water seeps through the soil or through tiny cracks in rock. Some ground water flows in underground rivers.

Hydrologists study the water cycle to locate sources of fresh water. They help choose the best sites to drill wells to find ground water in desert areas. Hydrologists also help plan dams and irrigation projects.

Hydrologists try to prevent or reduce water pollution. They study the effects of pollution as it moves through the water cycle.

Hydrographers use a *sonar transducer* to obtain information about the ocean floor.

Hydrology provides information needed to predict and control floods. Architects and civil engineers use this information to help plan towns and roads near waterways where floods often occur.

Hydrolysis is a chemical reaction involving water as one of the reacting substances. Its name comes from the Greek prefix *hydro-,* meaning *water,* and the Greek word *lysis,* meaning a *loosening.* In industry hydrolysis is important in making soap, sugar, alcohols, hydroxides, and silicones.

Hydrolysis produces either of two chemical changes: (1) the acidity of the reacting system may change, or (2) molecules of both water and another substance may split and recombine to form new substances.

An example of hydrolysis that increases the acidity of a system is the reaction of antimony chloride ($SbCl_3$) with water. This hydrolysis produces antimony oxychloride ($SbOCl$) and hydrochloric acid. In the chemical equation, the presence of the acid is indicated by the *hydronium ion* (H_3O^+). This equation is written:

$$SbCl_3 + 3H_2O \rightleftharpoons SbOCl + [2H_3O^+ + 2Cl^-]$$

An example of hydrolysis that decreases the acidity of a system is the reaction of sodium carbonate (Na_2CO_3) with water. This hydrolysis forms a mixture of sodium ions (Na^+), bicarbonate ions (HCO_3^-), and hydroxide ions (OH^-). The chemical equation is written:

$$Na_2CO_3 + H_2O \rightleftharpoons 2Na^+ + HCO_3^- + OH^-$$

An example of hydrolysis in which molecules of both water and another substance split and recombine differently is the reaction of sucrose (cane sugar, $C_{12}H_{22}O_{11}$) with water in the presence of acid. This hydrolysis produces two simpler sugars, glucose and fructose. These simpler sugars have the same chemical formula ($C_6H_{12}O_6$), but they differ in molecular structure. The chemical equation for the hydrolysis of sucrose is:

$$C_{12}H_{22}O_{11} + H_2O \xrightarrow{\text{acid}} \underset{\text{glucose}}{C_6H_{12}O_6} + \underset{\text{fructose}}{C_6H_{12}O_6}$$

The hydrolysis of sucrose is an important part of digestion. Sucrose cannot be used by the body, but glucose and fructose can.

See also **Acid; Base; Neutralization.**

Hydrometallurgy. See **Metallurgy** (Leaching).

Hydrometer is an instrument used to determine the density of liquids. The design is based on Archimedes' principle that a body in liquid seems to grow lighter, and that the loss of weight is equal to the weight of the displaced liquid.

The hydrometer is usually a glass tube with a weight in the bottom. It sinks in the fluid to be measured. The level to which the weight sinks is compared with a scale on the side of the hydrometer. Suppose the hydrometer sinks 6 centimetres when placed in water. Then it is placed in another liquid and sinks to a level of 8 centimetres. The second liquid is 6 divided by 8, or 0.75 times as dense as water. By comparing known densities of the liquids to be measured, the amounts of the liquids mixed together can be determined.

One type of hydrometer, called a *lactometer,* is used to test the purity of milk. An *alcoholometer* is used to test alcohol. The strength of brine in the boilers of seagoing ships is tested with a *salinometer.*

One type of hydrometer is made especially to test storage batteries. It is called an *acidimeter,* and is used to determine the amount of acid in the batteries. The concentration of battery acid increases the density of the liquid in the battery.

See also **Density.**

Hydrophobia. See **Rabies.**

Hydrophone is an instrument used to listen to sounds transmitted through water. For example, the position of a submarine may be detected by the noise of its engines. The hydrophone employs the principle of a microphone. Max Mason, a staff member of the Naval Experimental Station in New London, Connecticut, U.S.A., invented the hydrophone during World War I. See also **Microphone.**

Hydrophyte. See **Plant** (Aquatic regions).

Hydroplane is a fast motorboat that skims over the water almost in the way a flat skipping stone does when thrown. The hydroplane's bottom is shaped to lift the hull as it speeds up, until the boat is "planing" over the surface. The shape of the bottom allows the pressure of the water to lift the boat and keep it on the surface as long as it keeps moving quickly. For this reason, the bottom must be flat, or only slightly curved. In some hydroplanes, the bottom is a single surface. Others have two or more separated bottom sections.

Many racing hydroplanes are called "three-point" boats. The only parts of the boat that touch the water at high speed are a float, or *sponson,* on each side of the hull, and the propeller.

See also **Motorboat racing.**

A hydrometer is an instrument frequently used by motor mechanics to measure the amount of acid in a storage battery.

Hydroponics is the science of growing plants without soil. Developed during the mid-1800's, it is also called *soilless agriculture, nutriculture,* or *chemical culture.*

Land plants normally obtain nitrogen, phosphorus, potassium, and other *nutrients* from the soil. Plants need these chemical substances for proper growth and development. Hydroponics involves growing plants in containers filled with water or with coarse sand, gravel, or other materials, known as *substrate materials,* to which nutrients have been added. The containers should be made of glass, metal, or plastic. They range in size from small pots for individual plants to huge tanks for large-scale growing.

Plants growing without soil require the same amount of light and warmth that they would if they were growing in soil. Growers who use hydroponics indoors provide a source of light and heat.

Methods of hydroponics. There are two main methods of growing plants without soil. They are *water culture* and *aggregate culture.*

In water culture, plants are suspended with their roots submerged in water that contains plant nutrients. The roots absorb water and nutrients, but do not anchor the rest of the plant. Therefore, the plants must be mechanically supported from above. Because oxygen is also taken up by the roots, air must be regularly pumped or mixed into the nutrient solution.

There are many different kinds of nutrient solutions. A basic solution might contain 3.4 kilograms of potassium nitrate, 0.65 kilogram of ammonium sulphate, 2.6 kilograms of magnesium sulphate, 1.5 kilograms of monocalcium phosphate, and 3 kilograms of calcium sulphate. Mixed together, these materials will provide enough nutrients for 5,000 litres of water.

Once the solution is in the tank, 5 litres of water containing 37 grams of manganous sulphate and 4 to 6 drops of concentrated sulphuric acid should be added to each 5,000 litres of solution once a month. In addition, 150 grams of ferrous sulphate in 5 litres of water should be added once a week.

In aggregate culture, although plants are grown without soil, the roots not only absorb water and nutrients, but also anchor the plant. Instead of being placed directly in a water and nutrient solution, the roots are placed in a substrate material, such as coarse sand, gravel, peat, perlite, or vermiculite. A nutrient solution is then repeatedly applied to the substrate material. The solution is either pumped up from below the roots or trickled down from above them.

Importance of hydroponics. Scientists have not proved that hydroponics produces sturdier plants and better and larger crops. However, growing plants without soil is an effective way to study the needs of plants. By varying the amounts of nutrients, scientists can find the best ratio for successful growth.

Some scientists have suggested using hydroponics for commercial crop production. In places where soil is not available, such as on ships at sea and in ice-covered Arctic areas, hydroponics is an effective alternative.

Good soil has the nutrients necessary for plant growth. When plants are grown without soil, all plant nutrients must be added to allow for proper growth. The nutrients a plant receives in its early growth stages will largely determine how well the plant will grow and its later quality. During this early period, it is difficult to know what the plant lacks. Only a person specially skilled at studying a plant's *foliage* (leaves) is likely to recognize signs of poor nutrition at this stage. By the time poor growth is noticed, it may be too late to correct the nutrient deficiency that caused it.

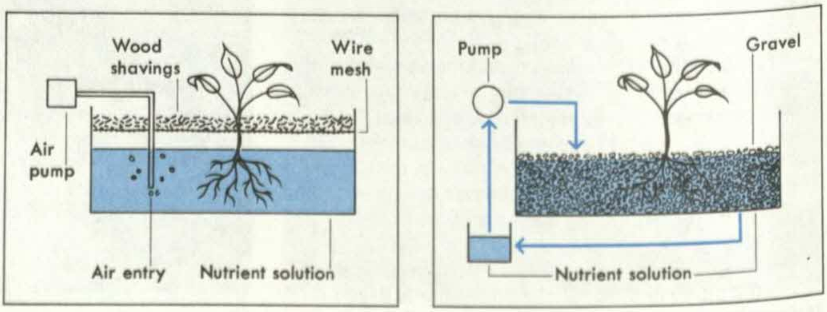
Hydrosphere. When we think of the earth, we think mostly of areas of land. But the land, or *lithosphere,* makes up only a small part of the world. Water, or the *hydrosphere,* makes up most of the earth's surface. We see the hydrosphere mostly in the basins of lakes and oceans, where it has an average depth of about 3.8 kilometres. In some parts of the Pacific Ocean, the hydrosphere is 9.7 kilometres deep.

The hydrosphere resembles another part of the earth, the *atmosphere,* because its pressure and temperature change at different depths. Oceanographers find that even in tropical oceans, the temperature at great depths is just a few degrees above freezing. The chemical content of the hydrosphere does not change with variations of temperature and pressure. But it does vary according to whether the body of water is fresh water or salt water. *Fresh water* is usually found in rivers and in lakes. It is composed of the chemical elements that make up water and of various other elements which depend upon the type of soil and rock surrounding the water. *Salt water* is found mostly in seas and oceans. In addition to the elements which make up water, it always has a high content of salt, or *sodium chloride.* Salt water also contains magnesium, sulphites, calcium, carbonates, bromides, and potassium. Small amounts of a number of other elements, such as gold, silver, and radium, are also found in salt water.

See also **Earth** (The earth's surface).

Growing plants by hydroponics

Hydroponics involves growing plants without soil by one of two chief methods. The plants may be suspended with their roots in a tank of water, *right,* or the roots can be placed in such material as coarse sand or gravel, *far right.*



Growing plants in water

Growing plants in gravel

Hydrostatics. See **Hydraulics.**

Hydrotherapy is a method of treating arthritic disorders and injuries by immersion in water. Some modern hospitals and clinics have hydrotherapy facilities in their departments of physiotherapy.

Warm water can be used to promote relaxation, to relieve chronic muscle and joint discomfort, and to improve joint flexibility. Warm water causes the small blood vessels near the skin's surface to *dilate* (widen), bringing more blood to the surface tissues to fight disease there. Warm water in a whirlpool bath is excellent for cleaning wounds in the treatment of burn patients. The buoyant effect of water is important when a patient is trying to regain strength in weak or partly paralysed muscles. In such cases, the patient may do exercises in a remedial pool.

Health resorts called *spas* offer medicinal bathing in mineral waters, therapeutic steam baths, and other forms of hydrotherapy. In Europe, famous spas are located in Karlovy Vary, Czech Republic; Vichy, France; and Baden-Baden, Germany.

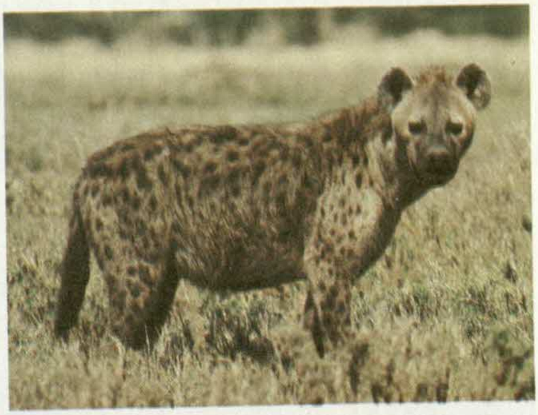
See also **Bath; Mineral water.**

Hydrotherapy is used to treat the burn victim shown above. The plastic lining of the whirlpool tank is provided for sanitary purposes. The lining is replaced for each patient.

Hydrotropism. See **Tropism.**

Hydroxide is a chemical compound consisting of a metal bonded to a hydroxide *ion.* The hydroxide ion has a negative charge and is composed of a hydrogen atom and an oxygen atom. Its chemical formula is OH^-. Many compounds containing the hydroxide ion dissolve in water solutions, producing *ionic solutions.* For example, sodium hydroxide ($NaOH$) dissolves to form sodium ions (Na^+) and hydroxide ions (OH^-) in water.

Basic hydroxides are the most familiar hydroxides. A dilute solution of ammonium hydroxide (NH_4OH) is household ammonia. Basic hydroxides in water solutions conduct electricity. They have a bitter taste and feel slimy or soapy. Strong basic solutions burn the skin. When a basic hydroxide combines with an acid, water and a salt are formed. Both the acid and the base are neutralized, thereby increasing the alkalinity of the resulting solution and reducing its acidity. Hydroxides are used to make such products as detergents, medicines, paper, and textiles.



The spotted hyena has massive, powerful jaws and strong teeth that can crack even large bones. Spotted hyenas hunt live prey and also feed on the remains of animals that they find dead.

Hyena is a mammal that is famous for its weird howl, which resembles a hysterical human laugh. The hyena hunts animals for its food. It also eats the remains of animals it finds dead.

The most common hyena is the *spotted,* or *laughing, hyena.* Other species include the *striped hyena* and the *brown hyena.* The spotted hyena lives in Africa, south of the Sahara. Its coarse fur is yellowish-grey with black spots. Striped hyenas live in northern Africa and from Turkey throughout the Middle East to India. They are smaller than spotted hyenas. Their coats are greyish, with narrow black stripes across the body and legs.

The brown hyena is found in southern Africa, south of the Zambezi River. It has long hair on its back. It has a coarse blackish-grey coat and stripes only on its legs.

Scientific classification. Hyenas belong to the hyena family, Hyaenidae. The spotted hyena is *Crocuta crocuta.* The striped hyena is *Hyaena hyaena.* The brown hyena is *H. brunnea.*

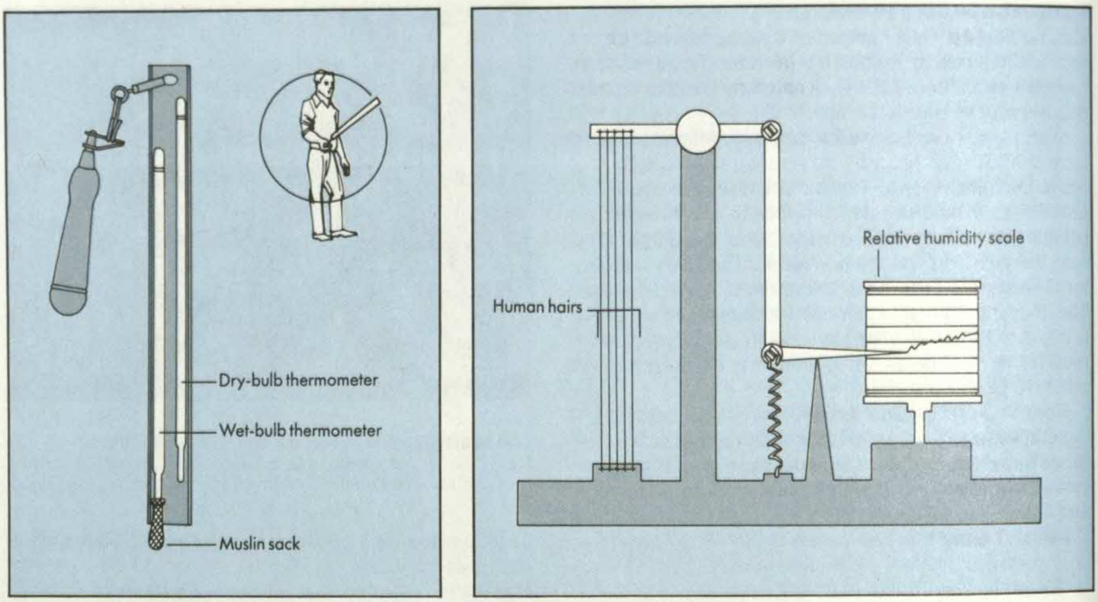
See also **Aardwolf.**

Hygiene. See **Health.**

Hygrometer is an instrument used to determine the *relative humidity.* Relative humidity is the amount of water vapour in the air compared with the amount required for saturation of the air at the same temperature. The most common hygrometers are the *psychrometer* and the *hair hygrometer.*

The psychrometer consists of two thermometers mounted on the same frame. One type of psychrometer, called the *sling psychrometer* or the *whirled psychrometer,* has a frame that can be whirled in the air by hand. The bulb of one thermometer is covered with a tight-fitting muslin sack and wetted with water. This thermometer is known as the *wet-bulb thermometer.* The other is the *dry-bulb thermometer.* The psychrometer is whirled to provide ventilation for the bulbs. The dry bulb indicates the temperature of the air. The wet bulb helps determine the relative humidity.

When the sling psychrometer whirls through the air, water from the muslin evaporates. The evaporating water cools the wet bulb. The amount of cooling that occurs depends on the relative humidity. The lower the



Hygrometers measure the amount of moisture in the air. They include the *sling* or *whirled psychrometer, left,* and the *hair hygrometer, right.* The psychrometer has two thermometers. The bulb of one is covered with a wet muslin sack. When the psychrometer is whirled in nonsaturated air, the wet bulb records a lower temperature than the dry bulb. The difference in temperature is converted to relative humidity with a chart. A hair hygrometer uses a bundle of human hairs to measure relative humidity. One end of the bundle is connected to a lever that moves a pointer on a relative humidity scale. The humidity changes the length of the hair, moving the pointer.

humidity, the faster the water in the muslin will evaporate, and the more the bulb will cool. High humidity will cause less evaporation, slowing the cooling process.

In air that has less than 100 per cent relative humidity, the wet bulb will record a lower temperature than the dry bulb. This difference in temperature is known as *wet-bulb depression.* A special chart is used to convert the wet-bulb depression to relative humidity.

The *Assman psychrometer,* an extremely accurate type of psychrometer, has a built-in fan. The fan draws the proper amount of air through two stationary metal tubes that hold wet-bulb and dry-bulb thermometers.

The hair hygrometer uses a bundle of human hairs to detect relative humidity. The length of the hair increases as it absorbs moisture from the air. One end of the bundle is anchored. The other end is attached to a lever that moves a pointer on a scale. As the humidity lengthens or shortens the hair, the lever moves the pointer on the scale, indicating the relative humidity.

Other hygrometers measure relative humidity by different methods. An *absorption hygrometer* uses a chemical that absorbs water vapour from the air. The chemical gets heavier as it absorbs the moisture, and the change in weight is measured to determine relative humidity. An *electrical hygrometer* uses carbon or some other substance whose electrical resistance responds to changes in humidity. A *dew-point hygrometer* measures *dew point,* the temperature at which the air has 100 per cent relative humidity (see **Dew point**). Its polished surface is chilled until dew appears. A device on the surface measures the temperature at which the dew forms.

See also **Humidity** (picture: To make a hygrometer).

Hyksos were invaders from Palestine and nearby areas who settled in ancient Egypt in the 1700's B.C. They gradually seized control of Egypt from the *pharaohs* (kings). The Hyksos dominated Egypt until 1570 B.C. They introduced the horse, the horsedrawn chariot, new weapons, and perhaps a new type of fortification in Egypt. These changes later helped Egypt to build a vast empire. The Hyksos are sometimes called *shepherd kings,* but the Egyptian word *Hyksos* actually means *chieftains of foreign countries.* See also **Egypt, Ancient** (The Middle Kingdom).

Hymenoptera. See **Insect** (table).

Hymn is a song of praise. Most hymns glorify God, but some honour a country or a hero. This article discusses only religious hymns.

The ancient Greeks sang hymns to their gods. Since Biblical times, Jews have used the Psalms of the Old Testament as hymns. Today, both Jews and Christians sing hymns during their religious services. There are more than 400,000 hymns. The largest number were originally written in German.

Words and music. Most hymns were originally written as poems and were later set to music. The music of a hymn is called the *hymn tune.* Some hymns have become closely associated with a certain tune, though the words and music may have been written by different persons. For example, "O God, Our Help in Ages Past" was written by Isaac Watts, an English clergyman. But this hymn is almost always sung to a tune created by William Croft, an English composer. In other cases, a hymn is sung to several tunes, or one tune is used for several hymns.

Until the 1900's, many hymnals had only the words to songs and were commonly considered books of poetry. In many churches, the people memorized certain hymn tunes, and the minister announced the tune for each hymn. Today, hymnals have both the words and the music. Many hymnals include tunes by great composers. A well-known example is "Hark, the Herald Angels Sing," written by Charles Wesley, an English hymnist, is sung to music by Felix Mendelssohn, a famous German composer.

History. Until the 1500's, most Christians sang hymns in Latin. During the Protestant Reformation, which began in Europe in 1517, many churches began to conduct religious services in their national language. Martin Luther, a German leader of the Reformation, wrote numerous hymns in German and translated a number of Latin hymns. In England, Switzerland, and other countries where many churches followed the teachings of John Calvin, a French-born religious reformer, most Christians sang only Biblical Psalms during religious services. As a result, verse translations of the Psalms became the chief hymns in those countries.

During the 1700's, Isaac Watts, known as the Father of English Hymnody, broke the tradition of basing hymns on the Psalms and wrote many original hymns. Charles Wesley, another great hymnist of the 1700's, wrote about 9,500 sacred poems, most of which were sung as hymns. Over 500 of Wesley's hymns are still sung.

Related articles in ***World Book*** include:

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Watts, Isaac
Wesley, Charles

Hyndburn (pop. 76,500) is a local government district in northern Lancashire, England. It contains the towns of Accrington, Church, Clayton-le-Moors, Great Harwood, Oswaldtwistle, and Rishton, and the parish of Altham. Accrington is the district's administrative centre. Once famous as a cotton-weaving and engineering area, Hyndburn now also has a wide range of other industries, including brickmaking and printing, and producing car parts, chemicals, paper, and plastics. See also Lancashire.

Hyperactivity, also called *attention deficit hyperactivity disorder (ADHD),* is a common behaviour disorder of children. It also affects some adults. Children who have ADHD are generally more fidgety and restless than other children. They have difficulty maintaining attention, avoiding distractions, and controlling impulses. Because diagnosis of ADHD can be inexact, experts disagree on how many children have the disorder. Most research indicates that ADHD affects 2 to 5 per cent of elementary school children. The disorder affects more than twice as many boys as girls. Experts also disagree on the causes and treatment of ADHD.

Hyndburn's residents live with industry. One street of houses stands in front of a set of cooling towers.

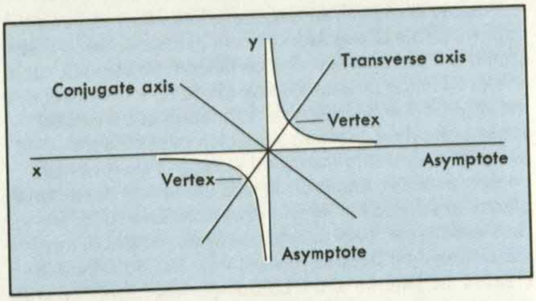
Most children with ADHD are hyperactive chiefly in group situations, particularly in school. In one-to-one situations and in situations where they receive constant feedback, such as when playing a video game, most children with ADHD can control their behaviour fairly well. Many hyperactive children have difficulty making or keeping friends. Some children with ADHD are more aggressive than other children. These hyperactive children are at a higher than normal risk of having behavioural problems or becoming alcohol or drug abusers as teenagers and adults.

Many therapists feel that children with ADHD benefit from a therapy method called *behaviour modification.* This method uses rewards to encourage appropriate behaviours. Most physicians believe that medications can also help children with ADHD. The medications most frequently prescribed are stimulants, such as methylphenidate (known by the trade name Ritalin). These drugs apparently enhance attention by stimulating the parts of the brain that control brain activity.

Some experts believe that ADHD is caused solely by social factors, such as lack of a caring environment at home or at school. However, research suggests that many cases have a genetic basis. As many as half of all children with ADHD continue to have difficulties with inattention, distraction, and disorganization in adulthood.

Hyperbola is a curve with two branches formed by a plane that cuts through two right circular cones that are joined at their tips. Circles, ellipses, hyperbolas, and parabolas all intersect a cone-shaped surface and so are called *conic sections.*

The equation $y=\frac{1}{x}$, when graphed, shows a hyperbola. As x increases, the curve flattens out and approaches a straight line called an *asymptote.* The two points at which the axis of a hyperbola's plane intersects the two branches are called the *vertices.* The *transverse axis* connects the vertices. A line called the *conjugate axis* bisects the transverse axis and is perpendicular to it.



A hyperbola can be produced by graphing the mathematical equation $y = \frac{1}{x}$, as shown in the diagram above.

Hyperbole is a figure of speech which is an exaggeration. People often use expressions such as "I nearly died laughing" and "I tried a thousand times." Such statements are not literally true, but people make them to sound impressive or to emphasize something, such as a feeling, an effort, or a reaction. Sometimes there is humour in such statements, and usually everybody knows they are not true. Hyperbole is common in everyday speech and in literature.

See also **Figure of speech; Humour** (The humour of words); **Metaphor.**

Hypericum. See **Saint-John's-wort.**

Hyperkinesia. See **Hyperactive child.**

Hyperopia. See **Farsightedness.**

Hypertension is the medical term for the disease commonly called *high blood pressure.* There are many varieties of hypertension. They range from mild forms to an extremely severe—and often rapidly fatal—type called *malignant hypertension.* High blood pressure is not only a serious condition by itself, but it is also the leading cause of heart attacks, strokes, and kidney failure. Many people of all ages suffer from hypertension.

Measurements of blood pressure are written as two numbers. For example, the normal blood pressure for a young adult is 120/80. The first number refers to the *systolic pressure,* which is the blood pressure when the heart is contracting. The second number refers to the *diastolic pressure,* which is the blood pressure when the heart is relaxing. Many doctors believe that a reading greater than 150/95 for an adult indicates hypertension. For more information about such figures and how doctors obtain them, see **Blood pressure.**

Causes. As people become older, their blood pressure usually rises because their arteries become less elastic and the blood flows more slowly. Some cases of hypertension result from other illnesses, such as kidney disease or overactive adrenal glands. However, doctors cannot determine the cause of high blood pressure in about 90 per cent of the cases. They call such cases *essential hypertension.* People whose parents have hypertension are much more likely to develop the ailment than those whose parents have normal blood pressure. *Obesity* (fatness), stress, smoking, or eating too much salt may trigger hypertension in people who have inherited such a tendency, and may also make the disease worse in people who already have it.

Doctors know that an enzyme called *renin* plays an important role in regulating blood pressure. Renin is secreted by the kidneys under certain circumstances, such as a drop in the pressure of the blood flowing through the kidneys. Renin causes the formation of a chemical substance called *angiotensin,* which raises the blood pressure by causing the blood vessels to *constrict* (become narrower). Angiotensin also stimulates the adrenal glands to secrete the hormone *aldosterone.* Aldosterone causes the body to retain sodium, which, in turn, then causes the body to retain fluids. The extra fluid increases the volume of the blood, thereby further raising the blood pressure. After the blood pressure has risen to a certain level, the kidneys normally stop secreting renin. But in many people with essential hypertension, something interferes with this controlling system. In such cases, the blood pressure remains elevated. When the pressure is high inside the heart, the heart releases a hormone called *atrial natriuretic factor.* This hormone helps lower the blood pressure by inhibiting the secretion of renin and aldosterone.

Effects. In most cases, hypertension produces no symptoms until dangerous complications occur. For example, it can cause an artery in the brain to burst, producing a stroke. High blood pressure also forces the heart to work harder, and so it may cause a heart attack. The disease can cause kidney failure by reducing the flow of blood to the kidneys. In addition, high blood pressure is a major cause of *arteriosclerosis* (hardening of the arteries).

Treatment. People of all ages should have their blood pressure checked frequently. Many cases of mild hypertension can be controlled by weight reduction, avoidance of salty foods, and increased exercise. Doctors can control almost all other cases with drugs, including some medications that reduce the secretion of renin and aldosterone. The more serious consequences of hypertension, such as heart attacks and strokes, can be prevented by treating high blood pressure before it reaches dangerous levels.

See also **Reserpine.**

Hyperthyroidism. See **Thyroid gland.**

Hyperventilation is abnormally rapid, deep breathing. It occurs most frequently if anxiety or emotional stress stimulate the part of the brain that regulates breathing. Certain illnesses, such as pneumonia, kidney failure, or diabetes, may also trigger hyperventilation. However, in itself, the condition is rarely a serious medical problem.

During hyperventilation, a person exhales too much carbon dioxide. As the level of carbon dioxide in the blood drops, the blood vessels narrow, allowing less blood to circulate. If too little blood reaches the brain, the person feels dizzy and may faint. The calcium in the blood also decreases, causing some muscles and nerves to twitch. The twitching may result in a tingling or stabbing sensation near the mouth or in the chest.

Some symptoms of hyperventilation resemble those of certain heart or lung ailments. These symptoms include a tight feeling in the chest, as though the lungs cannot receive enough air. This sensation leads to faster and deeper breathing. The heart may begin to pound, and the pulse rate may rise. Such symptoms increase a person's anxiety, which can make the condition worse.

An attack of hyperventilation may last 30 minutes or longer. People who hyperventilate can help control attacks by trying to slow their breathing rate when symptoms of the condition appear. They can also practise stress-reducing techniques to control anxiety.

Hyphen. See **Punctuation.**

Hypipamee crater, in the Atherton Tableland, Australia, is the crater of an extinct volcano. It is located northwest of Cairns, in northern Queensland. It has the form of an open-topped pipe with water at the bottom. The volcano that formed the Hypipamee crater developed during the early Palaeozoic age, when volcanoes erupted continuously over the Atherton Tableland.

A single massive basaltic cylinder rising to 873 metres above sea level forms the walls of Hypipamee crater. The lake is surrounded for the most part by eucalypt woodland. The cone of the volcano and its volcanic ash have long since been eroded away.

Hypnos was the god of sleep in Greek mythology. The Romans called him Somnus. Hypnos was a kind and gentle youth, but he had the power to lull to sleep even the mightiest gods. His mother was Nyx, the goddess of night, but he had no father. Thanatos (Death) was his brother. Hypnos had hundreds of sons, called the Dreams. The most famous was Morpheus (see **Morpheus**). Hypnos lived in a large cave where he slept on a soft, dark bed. Everything in the cave helped bring about sleep. Lethe, the river of forgetfulness, flowed through the cave.

Hypnotic. See **Sedative.**

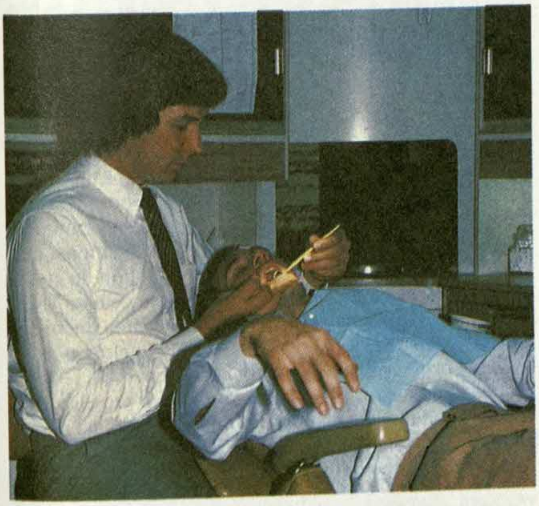
Hypnotism is the scientific and clinical use of *hypnosis.* Hypnosis, or a *hypnotic state,* is a temporary condition of altered attention in an individual. A *hypnotist* is a person who uses hypnotism. Scientific evidence suggests that hypnotism is useful when it is practised by qualified professionals. For example, some professionals use hypnotism to treat patients who have certain medical or psychological problems.

People have used hypnotic techniques since ancient times. But the practice of hypnotism has been condemned at times because of its misuse or because of ignorance, mistaken beliefs, and overstated claims. Today, professional organizations accept hypnotism when it is used for valid medical or scientific purposes.

What hypnotism is

Scientists have shown that hypnosis is a natural part of human behaviour that affects psychological, social, and physical experience. There is no magic connected with hypnotism, and the hypnotist has no special power. The effects of hypnotism depend on the willingness and motivation of the person being hypnotized. In hypnosis, a change in the quality and focus of a person's attention alters his or her internal and external experience.

Hypnosis has been compared to dreaming and sleepwalking. The term *hypnosis* comes from the Greek word *hypnos,* which means *sleep.* However, hypnosis is not actually related to sleep. It involves a more active and intense mental concentration. Hypnotized people can talk, write, and walk about. They are usually fully aware of what is said and done.



A hypnotized patient can undergo dental work with no pain or other discomfort. This patient has been told under hypnosis to keep his right arm raised. As long as his arm remains raised, the dentist knows he is still in a hypnotic trance.

British Museum, London

Hypnos, the god of sleep, is shown as a gentle, winged youth in this Roman copy of an original Greek statue.

A hypnotist uses certain methods to *induce* (guide) hypnosis in another person. As the person responds to the methods, the person's state of attention changes. This altered state often leads to various other changes or phenomena. For example, the person may experience different levels of awareness, consciousness, imagination, memory, and reasoning or become more responsive to suggestions. Additional phenomena may be produced or eliminated. Such phenomena may include sensations, blushing, sweating, paralysis, tensing of muscles, and *anaesthesia* (loss of pain sensation). Scientists have shown that changes in almost every body function and system may occur with hypnosis.

None of the experiences of hypnosis are unique. Some or all of the phenomena can occur without the use of hypnotic techniques. For example, people who are very responsive to hypnosis show an increased responsiveness to suggestions before they are hypnotized. This responsiveness increases during hypnotism.

People once believed that hypnotists could force their subjects to perform criminal acts or other actions against the subjects' will. There is no clear evidence to show that hypnosis causes such behaviour. Hypnotized people can and do resist suggestions. They do not lose control of their actions and can distinguish between right and wrong.

Public performances of hypnotism are responsible for many popular misconceptions about hypnosis. Many people are first exposed to hypnotism through a magic show or a film. Such presentations often make hypnotism appear simple. They may tempt untrained people to try to perform hypnotism on themselves or on other people.

The hypnotic experience

Some people can go into hypnosis within a few seconds or minutes. Others cannot be hypnotized easily. There are various levels of hypnosis. For example, with light hypnosis, the person becomes rested and follows simple directions easily. In deep hypnosis, complete anaesthesia may be experienced. In the treatment of medical or psychological problems, the level of hypnosis is not usually related to the effectiveness of treatment.

Inducing hypnosis in another person can be achieved through several techniques. Perhaps the best-known techniques use direct commands. These commands consist of simple suggestions repeated continuously in much the same tone of voice. The hypnotist instructs the subject to focus his or her attention on an object or fixed point, such as a spot on the ceiling. Then the hypnotist tells the subject to relax, breathe deeply, and allow the eyelids to grow heavy and to close.

Many professionals use verbal and nonverbal techniques known as *indirect inductions.* Such procedures usually omit the use of a focal object. The subject responds to a story or a mental puzzle presented by the hypnotist. The hypnotist does not tell the patient to relax or to close the eyes. Instead, the hypnotist suggests these actions indirectly through the story or puzzle. The hypnosis treatment remains much the same.

Some hypnotists give their subjects a challenge suggestion to test for hypnosis. For example, the hypnotist may say, "You will have difficulty moving your right hand." The person may then find the movement difficult or impossible to perform. Such tests do not necessarily indicate a hypnotic state. They may merely demonstrate a person's response to suggestion.

Historically, various drugs occasionally have been used to help induce hypnosis. However, drugs and special tools or other gimmicks are rarely necessary for inducing hypnosis. Most professionals do not make use of them.

Hypnotic phenomena. There are many individual differences in what a person experiences with hypnosis. A hypnotized person may experience changes in awareness, creative imagination, reasoning, and wakefulness. Physical changes within the body also may be produced by suggestion. These phenomena include changes in blood flow, blood pressure, heart rate, and sensations of cold and heat.

Professionals sometimes concentrate on a certain phenomenon of hypnosis to help treat their patients. One useful phenomenon is the ability of some hypnotized people to remember forgotten experiences. After people have a shocking or painful experience, they often *repress* (block) memories associated with the experience from their conscious thoughts. Sometimes, the repressed memories influence the individual's normal behaviour and may result in certain forms of mental illness. For example, during World War II (1939-1945), soldiers occasionally developed *amnesia* (loss of memory) as a result of some of their experiences. By hypnotizing these patients, doctors were able to help the patients remember their experiences and relieve the emotional tensions that had built up. This treatment helped the patients regain their health.

Another hypnotic phenomenon is called *age regression.* The doctor or therapist suggests that the hypnotized patient is a certain age. The patient may then recall or "relive" incidents in his or her life. If the hypnotist suggests that the patient is 7 years old, for example, the patient may appear to talk, act, and even think much as a 7-year-old. In this way, patients may remember events and feelings that may have had some bearing on their present illness. The patient can then reinterpret the situation with additional information, new insights, and increased coping skills.

Sometimes, at the hypnotist's command, subjects may believe they are living in some past or future time. They may feel that they have travelled back to the Middle Ages or on to the next century. Untrained hypnotists may look upon such changes as proof that the individual was or will be reincarnated. Most professionals consider these fantasies to be much the same as dreams and unrelated to past or future reality.

Ending the hypnosis session is generally not difficult. A person usually remains in hypnosis until given a signal by the hypnotist. The hypnotist may count to five, make an indirect suggestion, or produce some type of sound. Sometimes the subject ends the experience even when no signal is given. Occasionally a hypnotist may have difficulty ending the hypnosis. This problem is one of the reasons why only trained professionals should practise hypnotism.

Uses of hypnotism

Modern methods of hypnotism have helped scientists increase their understanding of the human mind and body, and normal and abnormal behaviour. Hypnotism is used in research; in medicine, particularly surgery and dentistry; and in psychotherapy (see **Psychotherapy**). Hypnosis has occasionally been used in legal cases.

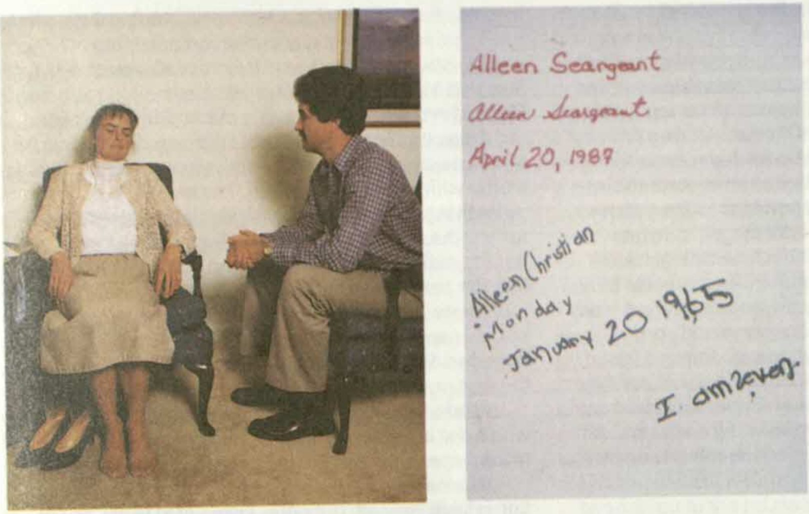
Hypnotism has been the subject and a tool in many studies. Tests have been developed to measure a person's hypnosis experience. Research into people's susceptibility to hypnosis has shown that children can usually be hypnotized more easily than adults and that males and females can be hypnotized.

Some doctors use hypnosis as a sedative to soothe patients who are nervous or in pain. Some patients become less aware of pain with hypnosis, while others report no pain at all. Doctors may use deep hypnosis as a form of anaesthesia, so that patients will feel no pain while undergoing surgery or childbirth. Hypnotism has also been used to lessen the discomfort of patients recovering from surgery or other medical procedures.

Doctors also have made use of the ability of a hypnotized person to remain in a given position for long periods of time. In one case, doctors had to graft skin onto a patient's badly damaged foot. First, skin from the person's abdomen was grafted onto his arm. Then the graft was transferred to his foot. With hypnosis, the patient held his arm tightly in position over his abdomen for three weeks, then over his foot for four weeks. Even though these positions were unusual, the patient at no time felt uncomfortable.

Some dentists may use hypnotism as an anaesthetic. After the patient has been hypnotized, the dentist drills the tooth and fills the cavity. The patient remains relaxed and feels comfortable throughout the procedure.

Mental health professionals who may use hypnotism include psychiatrists, psychologists, and clinical social workers. Therapists may use hypnosis as the main focus or as a part of the treatment. Hypnotism may be used to calm disturbed patients. This treatment may help the patients to become more aware of their feelings, modify



Under hypnosis, people can sometimes be made to believe they are living in an earlier period of their lives. The woman in the photograph has been told under hypnosis that she is 7 years old. The top of the illustration on the left shows how she wrote her name and the date before hypnosis. The bottom portion shows these items as she wrote them while hypnotized.

their behaviour, and learn new ways of thinking and solving problems. Psychological conditions that have been treated through hypnosis include anxiety, depression, phobias, stress, and problem solving.

Hypnosis helps some people control or stop such problem habits as eating disorders and smoking. Hypnotism has been used to improve learning, reading, sleep, speech problems, sports performance, and behavioural problems.

Hypnotism can also be effective in controlling certain physical problems that are linked to psychological factors. These so-called *psychophysiological* problems include certain conditions in the nervous system, as well as some ailments of the heart, stomach, and lungs. Hypnotism occasionally has aided in the treatment of patients with chronic illnesses like arthritis, cancer, multiple sclerosis, pain, and stroke.

Hypnosis occasionally has been used with witnesses and victims of crime. In hypnosis, people may remember important clues, such as a criminal's physical appearance or another significant detail that might help in solving the crime. Care must be taken to also obtain independent information as people can lie and make mistakes while hypnotized. Hypnosis cannot make a person give away a secret.

Dangers of hypnotism

Hypnotism can only be dangerous if it is abused. Only a qualified professional should practise hypnotism. Although many people can learn to hypnotize, the skill is not a substitute for training in medicine and psychology. People who practise hypnotism need sufficient education and experience to be able to analyse a condition, determine that hypnosis is an appropriate treatment, and evaluate the results.

An untrained person cannot deal with the difficulties that might occur as the result of inappropriately hypnotizing an individual. For example, an unqualified hypnotist may give treatment for the wrong condition or may overlook significant details. An inappropriate suggestion may mask or cover an illness or symptom. If the hypnotist uses an incorrect method or approach, a symptom may be interpreted as a completely different problem. The symptom may remain undetected, and the subject may not learn the proper skills for solving the real problem. In addition, alternative treatment techniques may be ignored or may not be used effectively.

Some people learn self-hypnosis, also called *autohypnosis.* Self-hypnosis should be used only after an expert has determined that it is the appropriate treatment for the particular problem. A person learning self-hypnosis should have professional instruction. Complications may arise if self-hypnosis is practised incorrectly.

History

Throughout history, various cultures and groups have used rituals and techniques that can best be described as hypnotism. Hypnotic experiences have been described by the ancient Egyptians and Greeks and by tribal cultures. References to deep sleep and anaesthesia have been found in the Old Testament and in the Talmud, a collection of sacred writings of Judaism.

Mesmerism. The scientific development of hypnotism can be traced to the efforts of Franz Anton Mesmer, an Austrian doctor who became prominent during the 1770's. Mesmer called his work *animal magnetism.*

Some people believed that disease developed when invisible magnetic fluids were cut off or improperly distributed. Mesmer used water tubs and magnetic wands to direct the supposed fluids to his patients. Many patients claimed that this treatment cured them.

In 1784, a French commission was formed to study the claims of Mesmer and his followers. The commission reported that the magnetic fluids did not exist. It explained the cures as a product of the patients' imaginations.

Many of Mesmer's patients and students helped spread the belief in animal magnetism, which became known as *mesmerism.* Students of mesmerism continued to experiment with some of his methods. Some of these people soon found that magnets or fluids were unnecessary.

Scientific studies. The term *hypnotism* was used by James Braid, a British doctor who studied suggestion and hypnosis in the mid-1800's. Braid pointed out that hypnosis differed from sleep and that hypnotism was a physiological response in the subject, not the result of secret powers. Perhaps Braid's most valuable contribution was his attempt to define hypnotism as a phenomenon that could be scientifically studied. During this same period, James Esdaile, a Scottish doctor working in India, began to use hypnotism as an anaesthetic in major surgery, including leg amputations. He performed about 200 operations with the aid of hypnosis.

During the late 1800's, the French neurologist Jean Martin Charcot performed landmark experiments involving hypnosis. He found that hypnosis relieved many nervous conditions. His clinic for nervous disorders achieved a widespread reputation among scientists of the time, including the French psychologist Alfred Binet and the Austrian doctor Sigmund Freud. Also in the late 1800's, the French doctors Hippolyte Bernheim and Ambroise Auguste Liébeault explored the role of suggestibility in hypnosis. These two scientists used hypnosis to treat more than 12,000 patients.

Freud was especially interested in the work of Charcot and Bernheim. He used hypnotized people in his early studies of the unconscious state. For various reasons, Freud abandoned the use of hypnosis in his clinical practice. However, he continued to view hypnosis as an important research phenomenon. Late in his life, Freud modified his once negative views on hypnotism. See **Freud, Sigmund.**

During the early 1900's, the Russian physiologist and psychologist Ivan Pavlov sought to discover a physiological basis of hypnosis. Pavlov maintained that hypnosis is based on *inhibition* (blockage) of certain nerve impulses in the brain.

Hypnotism became widely used by doctors and psychologists during World War I and World War II. Hypnosis was used to treat battle fatigue and mental disorders resulting from war. After the wars, scientists found additional uses of hypnotism in clinical treatment.

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Psychiatry
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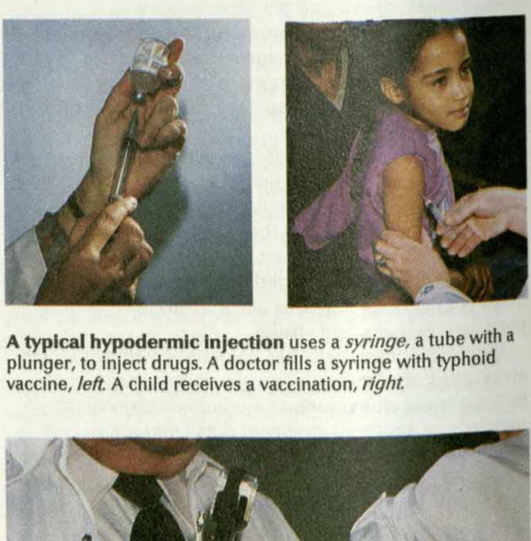
Hypochlorous acid is a weak, inorganic acid that forms when chlorine is added to water. It is unstable and decomposes rapidly when exposed to heat or light. Hypochlorous acid is used as a household bleach and disinfectant. Chemists believe that when chlorine is added to swimming pools and water supplies, it is the hypochlorous acid that forms which kills the bacteria. Neutralizing hypochlorous acid produces salts called *hypochlorites.* Both the acid and its salts are powerful oxidizing agents.

Hypochlorous acid is the weakest chlorine acid. Its chemical formula is $HOCl$, but it is sometimes written $HClO$. Hypochlorous acid is relatively unstable and has never been isolated in pure form. It usually occurs as a dilute solution of $HOCl$ in water.

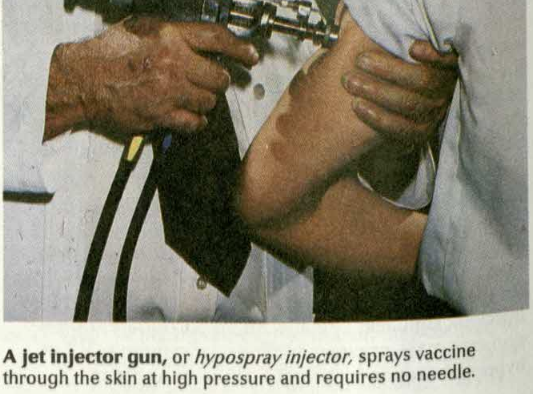
Hypochondria is a state of mind in which people obsessively worry about their health. Such people, convinced that they are ill, complain of numerous symptoms. They seek, and may receive, various medical treatments. But at best, they get only temporary relief because the underlying cause is psychological not physical. In popular usage, any person complaining of vague or persistent symptoms may be called a *hypochondriac.* See also **Mental illness; Neurosis.**

Hypodermic injection is a method for administering drugs under the skin. The equipment for the injection includes a *syringe* and a hollow needle. A syringe is a tube with a plunger attached. The needle has a sharp point that permits it to easily slip into the skin. The doctor attaches the needle to the syringe barrel, puts the liquid medicine in the syringe, and inserts the needle into the patient's skin. Then, the doctor presses on the plunger to force the medicine through the needle. The hollow needle was invented in 1844 by Francis Rynd, an Irish doctor. Charles Pravaz, a French doctor, invented the first practical metal syringe in 1853. See **Syringe.**

Hypodermic injections are named after the tissue into which the injection is made. *Intradermal injections* are made between the layers of skin. For these, the doctor inserts a needle just under the top layer of skin. Injections made beneath the outer layers of skin are called *subcutaneous injections. Intramuscular injections* are given into deep muscle tissue. A hypodermic needle



A typical hypodermic injection uses a *syringe,* a tube with a plunger, to inject drugs. A doctor fills a syringe with typhoid vaccine, *left.* A child receives a vaccination, *right.*



A jet injector gun, or *hypospray injector,* sprays vaccine through the skin at high pressure and requires no needle.

can be inserted into a vein to give medicine *intravenously* (see **Intravenous injection**).

Hypoglycaemia is a condition that occurs when the blood does not contain enough *glucose* (sugar). Glucose provides energy for the body's cells. Some cells require a continuous supply of glucose. The nerve cells, especially those of the brain, are most seriously affected by too little glucose.

The symptoms of hypoglycaemia may include hunger, dilated pupils, headache, nervousness, rapidly pounding heartbeat, and sweating. People suffering from severe hypoglycaemia may show confusion, poor coordination, and slurred speech. In advanced cases, the patient may have convulsions and lose consciousness. In rare cases, brain damage or even death occurs.

Most cases of hypoglycaemia occur among people who are taking medicine for diabetes. These people have too little *insulin,* a hormone that regulates the body's sugar. Their blood contains too much sugar, and so they take insulin or a hypoglycaemic drug to lower the blood sugar. Hypoglycaemia may occur if the dosage is too large or has a stronger effect than intended.

Doctors classify other cases of hypoglycaemia into two groups—*organic* and *functional.* Organic hypoglycaemia, which is much more severe than the functional condition, results from a physical abnormality. Various diseases of the liver may lead to organic hypoglycaemia. The liver normally stores sugar as *glycogen* (animal starch). The liver reconverts glycogen to glucose and releases it into the blood as the cells need it. A diseased liver may fail to release adequate amounts of glucose. Disorders of the *endocrine* (hormone-producing) glands may also result in organic hypoglycaemia. For example, some tumours of the pancreas, the organ that produces insulin, can release too much insulin. The treatment typically involves surgery to remove the tumour.

The major form of functional hypoglycaemia is *reactive hypoglycaemia,* which is an exaggeration of the body's normal reaction to eating. Normally, the amount of sugar in the blood increases for a few hours after a meal, especially one that includes many *carbohydrates* (starches and sugars). In many healthy people, the glucose level may drop to a point clearly lower than that before the meal, and then rise back to the starting level. In most people, this drop in blood sugar is not noticed. In a person who has reactive hypoglycaemia, the drop in blood sugar to below normal triggers symptoms of hypoglycaemia. In most cases, without treatment, the symptoms disappear in a few minutes—or even sooner if the person eats something that contains sugar.

Functional hypoglycaemia occurs far more frequently than organic hypoglycaemia, but it is not a common condition. Some doctors once did not realize that a temporary fall in blood sugar often occurs normally in response to eating. This lack of knowledge led to widespread wrong diagnosis of functional hypoglycaemia. Many common problems, such as fatigue, nervousness, and poor job performance, were blamed on the condition. Most doctors now agree that in most cases, these problems result from other causes. The answer for functional hypoglycaemia may include a diet that contains a planned balance of protein- and carbohydrate-containing foods.

Hypotenuse. See **Triangle.**

Hypothalamus is a small area at the base of the brain. It plays a key role in regulating the body's general level of activity. The hypothalamus helps control the *autonomic nervous system,* the part of the nervous system that regulates such involuntary body processes as breathing and heart rate. The hypothalamus also controls the *pituitary gland,* the so-called "master gland" of the body's *endocrine* (hormone-producing) system.

Certain parts of the hypothalamus regulate body temperature, breathing, sleep, hunger, thirst, urination, sexual drives, and emotions. Other portions produce hormones called *releasing hormones* or *releasing factors.* The releasing hormones travel in the bloodstream directly to the *anterior lobe* (front part) of the pituitary gland and control the secretion of individual pituitary hormones. The pituitary hormones, in turn, affect many of the body's endocrine glands. These glands secrete hormones that influence growth, sexual development, and the rate at which the body changes food into energy and living tissue.

In addition to the releasing hormones, the hypothalamus produces the hormones *vasopressin, oxytocin,* and *somatostatin.* These hormones are stored in, and released by, the *posterior lobe* (rear part) of the pituitary gland. Vasopressin, which is also known as *antidiuretic hormone,* reduces the amount of water lost from the body in urine. Oxytocin helps regulate the birth process and milk production in females. Somatostatin slows the secretion of growth hormone.

See also **Brain; Gland; Pituitary gland; Stress.**

Hypothermia is a condition in which the temperature of the human body is below the normal level of 37° C. It generally results from accidental exposure to cold. But surgeons may bring about hypothermia to perform various operations. During hypothermia, the activity of the organs and tissues slows down and their need for oxygen decreases.

Some cases of hypothermia occur among climbers, skiers, and others who get lost in cold weather. However, even exposure to indoor temperatures as high as 18° C can bring on hypothermia. Such cases occur most often among elderly people, many of whom lose the ability to sense cold. A victim of hypothermia may die if the body continues to lose heat. The body can be rewarmed by placing the victim in warm water and later wrapping him or her in warm blankets.

The heart rate and blood pressure decrease during mild to moderate hypothermia, that is when the body temperature is 35° to 28° C. Breathing is slower and shallower. From 30° to 28° C, the victim becomes unconscious. During deep hypothermia—18° to 15° C—the action of the heart, the flow of the blood, and the electrical activity of the brain stop completely.

Doctors may induce hypothermia to perform brain or open heart surgery, or other operations for which they want to re-route the circulation of blood. At the normal body temperature, many organs would be permanently damaged if they did not receive oxygen from the blood for more than a few minutes. The brain would be damaged beyond repair without oxygen for more than 3 to 5 minutes. But during deep hypothermia, the blood flow can be safely interrupted.

Hypothermia may be produced by putting the patient into ice cold water. If the doctor uses a heart-lung machine, the blood can be cooled before it reenters the patient's body (see **Heart** [Treatment of heart problems; picture]). Sometimes these methods are combined. The body temperature is returned to normal by heating the blood as it goes through the heart-lung machine, or by placing the patient in special blankets or warm water.

Hypothesis. See **Science** (Forming a hypothesis).

Hyrax is the name of a family of rabbit-sized animals that resemble guinea pigs. There are eleven species of hyraxes. They are found in Africa and southwestern Asia. Hyraxes have short legs, ears, and tails. They have ridges on their feet and broad nails on their toes. Although hyraxes are the smallest of the hoofed mammals, their closest relatives are elephants.

A hyrax is a rabbit-sized animal that resembles a guinea pig. It feeds on plants.

There are three kinds of hyraxes: rock hyraxes, also known as dassies, bush hyraxes, and tree hyraxes. They all have scent glands in the middle of the back, possibly for use in marking out territory. Shy creatures, hyraxes are known for their ear-splitting calls.

Hyraxes are sometimes known as conies, and in fact these are the conies mentioned in the English version of the Bible. Certain other rabbit-like animals, rabbits, and fishes are called *conies.*

Scientific classification. Hyraxes belong to the order Hyracoidea. They make up the hyrax family, Procaviidae.

Hyssop is a bushy evergreen shrub of the mint family. The plant comes from southern Europe. The hyssop has a square, coarse stem from 30 to 60 centimetres high. The seeds, flowers, and green parts of the plant have a strong odour and taste. At one time, people used hyssop to season foods and as a medicine. Most people prefer milder flavours today, and they no longer use it as a herb. Hyssop has purple-blue flowers and gardeners plant hyssop as a shrub for the borders of lawns and gardens. The flowers are also very attractive to bees.

Hyssop

Scientific classification. The hyssop belongs to the mint family, Labiatae (Lamiaceae). It is *Hyssopus officinalis.*

Hysterectomy is the surgical removal of the *uterus* (womb), the organ in which unborn babies develop. This surgery also includes the removal of the Fallopian tubes. If only the uterus and Fallopian tubes are taken out, the operation is called a *subtotal hysterectomy.* A total hysterectomy includes the additional removal of the *cervix,* the so-called neck of the womb. In some cases, the surgeon also removes one or both ovaries. See the **Reproduction** article for an explanation and diagram of the female reproductive system.

Menstruation ends after a woman has a hysterectomy, and she can no longer become pregnant. The "hot flushes" or other symptoms of hormonal changes that sometimes accompany menopause do not occur unless both ovaries have been removed (see **Menopause**).

The most common reason for a hysterectomy is the growth of fibroid tumours on the uterus. Such tumours are not cancerous, but they may cause pain or heavy bleeding. A hysterectomy may also be necessary if hormonal imbalances produce irregular or extremely heavy uterine bleeding. Other reasons for the operation include cancer, a long-term infection, or the shifting of the uterus from its normal position.

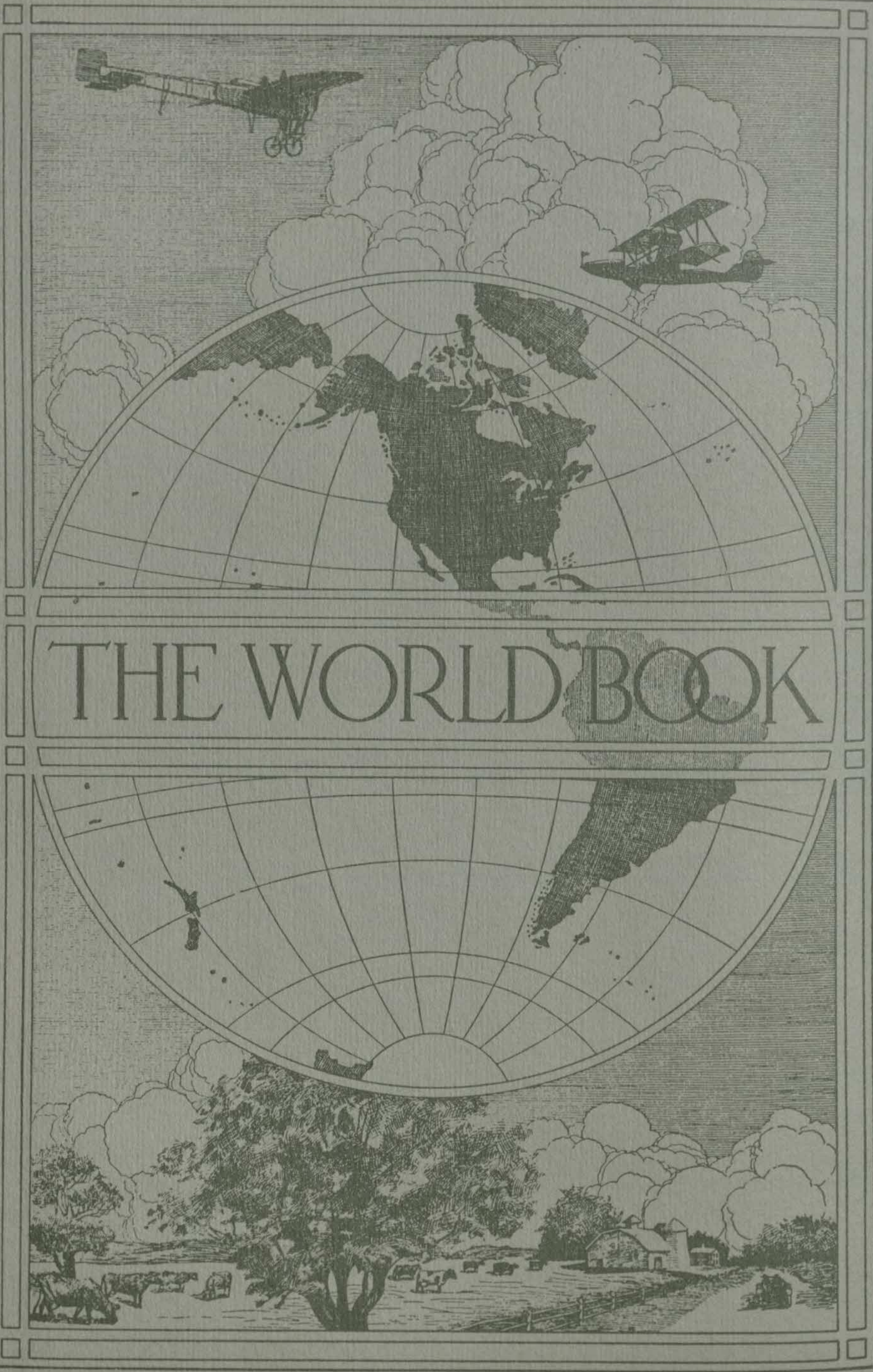
Hysteria is a neurotic illness in which a person has physical symptoms, and yet no physical cause can be found. The ancient Greek doctor Hippocrates was one of the first to identify this disorder. He noticed that hysteria was common in women and thought it was caused by a displaced uterus. The word *hysteria* comes from *hystera,* the Greek word for *uterus.*

A person with hysteria may have any sort of physical complaint. The person may complain of heart disease, paralysis, sexual problems, stomach pains, vomiting, or weakness of the arms or the legs. In this way, hysteria may imitate any of many physical illnesses. Sometimes, the complaints are so frequent or severe that a doctor may think the patient actually has a physical illness, such as appendicitis. In these cases, the diagnosis of hysteria might not be made until surgery indicates that no physical illness is present.

People are often called hysterical when they are upset, excited, and unable to control their feelings. We often hear of "hysterical weeping" or "hysterical rage." Such outbursts of feeling may have nothing to do with the disorder that psychiatrists call hysteria. In some cases, they occur in normal people. They may also occur in people who have mental illnesses other than hysteria, as well as in those with hysteria.

Psychiatrists usually treat hysteria by using some type of psychotherapy or behaviour therapy. Treatment with drugs and hypnosis may also be used along with the psychotherapy. The causes of hysteria are still not known, but the disorder remains more common in women than in men.

Hywel Dda, or Howel the Good (? -950), was a king of Wales and a lawgiver. Hywel probably succeeded his father as ruler of Ceredigion in about A.D. 909. By 918 to 920, Hywel was king of South Wales. In 928, he made a pilgrimage to Rome. Upon his return, he kept close contact with the Anglo-Saxon court. In 942, Hywel became king of a united Wales. He devised a code of laws to replace tribal codes. After he died, the kingdom broke up.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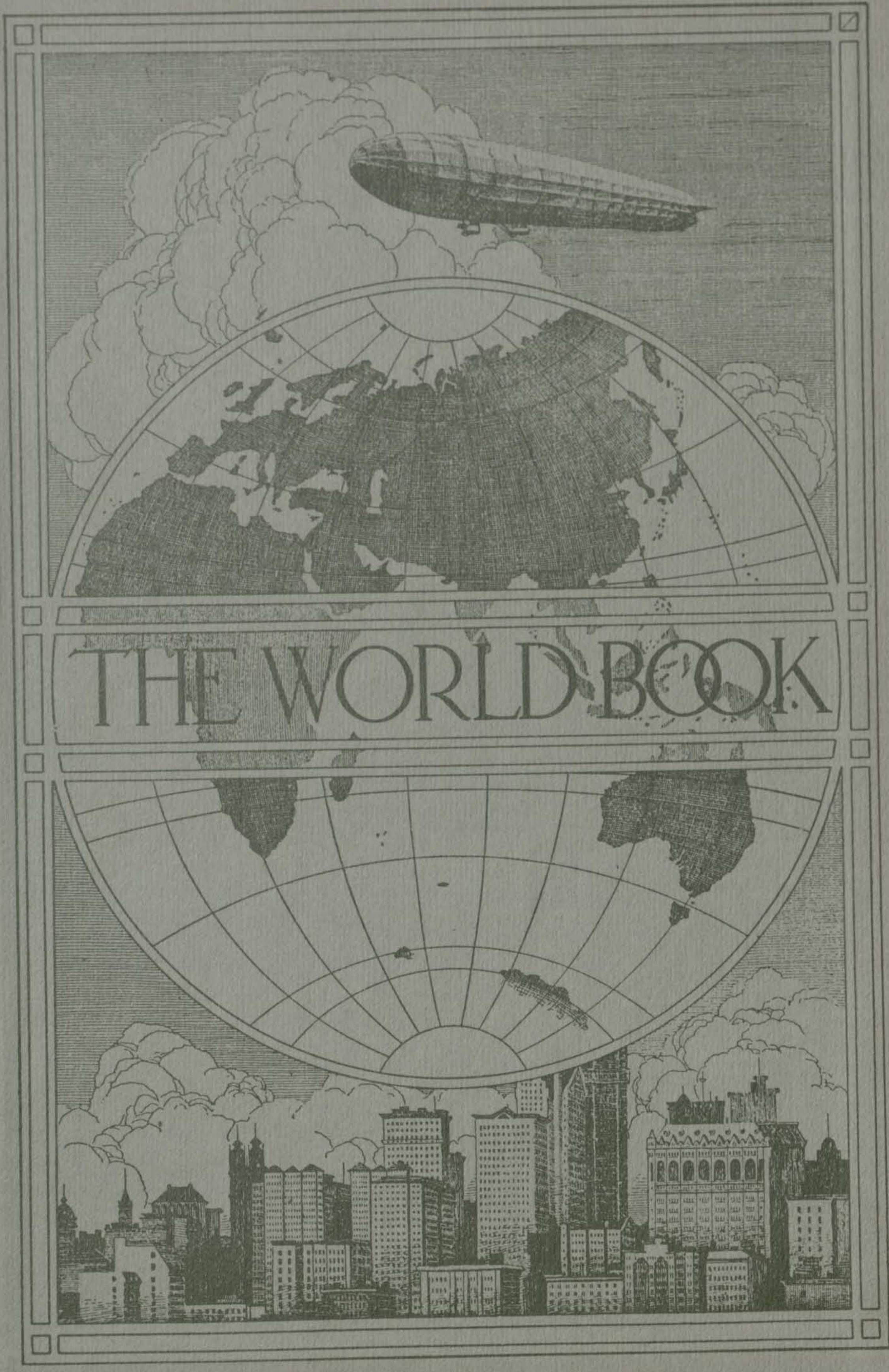
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